ELEMENTS OF OPTICAL MINERALOGY

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AN INTRODUCTION TO
MICROSCOPIC PETROGRAPHY

BY

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SECOND EDITION, SECOND PRINTING

PART III. DETERMINATIVE TABLES

WITH A COLORED CHART AND TWO DIAGRAMS

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PREFACE TO THE SECOND EDITION
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During the ten years since the publication of the second edition of these tables many new minerals have been described. About fifty of these are included in the third edition of Part II, which was published in 1933, while nearly seventy are of more recent date. The author has attempted to include in supplementary tables in this printing all the new minerals which seem to be well established and adequately described as to their optical properties. Unfortunately it has not been feasible to incorporate them in the main tables, but this is probably not a very serious difficulty since the minerals in question are all very rare.

It is hoped that the use of colored paper for the table (III) classifying minerals on the basis of their color (and pleochroism) in thin section will make it easy to find the various tables quickly and conveniently.

In the preparation of this printing the author has benefited by the assistance and encouragement of his wife, Florence S. Winchell.

Alexander N. Winchell

Madison, Wisconsin
March, 1939

PREFACE TO THE SECOND EDITION

OF course tables prepared for the determination of minerals by optical methods should be based on the chief optical properties of the minerals. However, it is not at all obvious just which optical property should be used first in classifying the minerals. After several attempts to combine the most important properties in one table so that more than one of them could be used first, it seemed wiser to simplify the arrangement by making separate tables for each important property. In addition to the tables which are given, tables might be prepared based primarily upon the optic angle, optic sign, or extinction angles. However, the practical groups based upon optic angle or optic sign are too few in number to be satisfactory, while extinction angles are almost useless in distinguishing between tetragonal, hexagonal and orthorhombic minerals. Thus it comes about that the chief tables which are given are based upon refringence, or birefringence, or color (and pleochroism). As the dispersion methods of determining minerals come into wider use the table based upon dispersion will become more complete and more useful.

It is a pleasure to acknowledge that these tables have been improved as a result of thoughtful constructive criticism of the first draft by Professor F. F. Grout of the University of Minnesota; the writer has also had the advantage of an opportunity to examine copies of determinative mineral tables prepared by Professor Grout and others prepared by Professor D. J. Fisher of the University of Chicago. He has also benefited notably by frequent consultations with Professor R. C. Emmons of the University of Wisconsin.

Plate II, based on refringence and birefringence, has been prepared along lines suggested by Professor C. O. Swanson of the Michigan College of Mines and Professor R. H. B. Jones of the State College of Washington.

ALEXANDER N. WINCHELL.

MADISON, WISCONSIN,
January, 1929

CONTENTS

ILLUSTRATIONS

(In Pocket at Back)

ABBREVIATIONS USED IN THE TABLES

(Miller symbols and chemical formulas need no explanation here)

a = front and rear crystal axis.
Abn. = abnormal
Abs. = absorption
Acic. = acicular
Alter. = alteration
Ang. = angle
Aniso. = anisotropic
Antim. = antimonate
Arsen. = arsenate

b = right and left crystal axis
Biax. = biaxial
Biref. = birefringence
Bl. = blue
Bor. = borate
Br. = brown
Bx. = bisectrix

c = vertical crystal axis
Carb. = carbonate
Chem. = chemical (nature or composition)
Chrom. = chromate
Cin. = cinnamon
Cl. = cleavage
Cleav. = cleavage
Col. = color
Coll. = colloidal
Colum. = columbate
Comp. = complex
Conch. = conchoidal
Cont. = continued
Cub. = cubic
Cryst. = crystal

Dec. = decomposed by
Decrep. = decrepitates
Deliques. = deliquescent
Disp. = dispersion
Dist. = distinct
Dodec. = dodecahedral
Dom. = domatic

Efferv. = effervesces (with acid)
El. = elongation
Elong. = elongation
Eq. = equant
Ext. = extinction
Extr. = extreme

Fib. = fibrous or fibers
Frac. = fracture

G. = specific gravity
Gel. = gelatinizes with
Gr. = green
Gran. = granular

H. = hardness
Hal. = halide
Hex. = hexagonal
Hygro. = hygroscopic

Ign. = igneous
Incl. = inclusions
Insol. = insoluble
Int. = interference
Is. = isometric
Isom. = isometric
Isotr. = isotropic

Lam. = lamellar
Lg. = large

Mass. = massive
Max. = maximum
Mod. = moderate
Molyb. = molybdate
Mon. = monoclinic

N = index of refraction
N_e = index of refraction for the extraordinary ray
N_g = greatest index of refraction
N_m = mean index of refraction
N_o = index of refraction for the ordinary ray

N_p = least index of refraction
Nit. = nitrate

Oct. = octahedral
Opt. = optic
Or. = orientation
Orth. = orthorhombic
Ox. = oxide
Oxal. = oxalate

Part. = parting
Perf. = perfect
Phos. = phosphate
Pinac. = pinacoidal
Pleo. = pleochroic or pleochroism
Prism. = prismatic
Pneumat. = pneumatolytic
Pt. = parting
Ps. = pseudo.
Pyr. = pyramidal

Rh. = rhombohedral
Rhom. = rhombohedral

Sel. = selenate
Sil. = silicate
Skel. = skeleton
Sm. = small
Sol. = soluble in
Str. = strong
Sul. = sulphate
Syst. = system

Tab. = tabular
Tant. = tantalate
Tel. = tellurate
Tet. = tetragonal
Tetar. = tetartohedral
Tet'h. = tetrahedral
Tit. = titanate
Tr. = triclinic.
Trap. = trapezohedral
Tung. = tungstate
Twin. = twinning

V = half of true optic angle
Van. = vanadate
Var. = variable
Vit. = vitreous

X = vibration dircetion of the fast ray
Y = vibration direction of the intermediate ray
Yel. = yellow

Z = vibration direction of the slow ray

$>$ = greater than
$\geq$ = greater than or equal to
$<$ = less than
$\wedge$ = angle between
$\perp$ = normal to
$\parallel$ = parallel to
$\pm$ = plus or minus (or nearly)

The sign of the extinction angle in monoclinic minerals is positive when it is measured in the obtuse angle between a and c and negative when it is measured in the acute angle β.

OPTICAL MINERALOGY

Part III

INTRODUCTION

DETERMINATIVE TABLES

In order to use determinative tables based on optical properties successfully the worker must be familiar with optical principles and the methods of applying them to the measurement or estimation of the optical properties of minerals; these topics are discussed in Part I of this work.

The following tables are as complete as available data permit so far as transparent or translucent minerals are concerned. Only a few of the commoner opaque minerals are included, because the ordinary petrographic methods are not well adapted for the study of such minerals.

In general, the tables summarize the data for the minerals described in Part II of this work. In some cases minerals are described somewhat incompletely in Part II and this condition may lead to their necessary omission from one or more of the tables composing (this) Part III. In a few other cases, data, published since the appearance of Part II, have been used in the tables. The tables include all natural minerals whose optic properties are known.

The first of the following tables deals with the common opaque minerals; so far as these are always opaque in standard thin sections they are not included in the other tables. Those minerals which are sometimes opaque and sometimes translucent in thin section are included in this first table and also in the other tables, so far as available data regarding them permit.

The second table which follows is based primarily upon the birefringence of minerals and secondarily upon their refringence. In order to use this property of refringence with more precision the following scale has been adopted:

SCALE OF REFRINGENCE

1. Fluorite, $N = 1.434$. Negative distinct. $N < 1.48$.
   Limit: Natrolite, $N_m = 1.48\pm$. Castor oil, $N = 1.48\pm$.

2. Leucite, $N = 1.509$. Negative low. $N > 1.48 < 1.54$.

Limit:	Microcline, $N_g = 1.529$.	Clove oil,	$N = 1.531$–1.533.
		Fennel oil,	$N = 1.54$.
	Quartz, $N_o = 1.544$.	Canada balsam,	$N = 1.533$–1.541.

3. Labradorite, $N_m = 1.557$–1.567. Positive low. $N > 1.53 < 1.59$.
   Limit: Muscovite, $N_m = 1.59\pm$. Bromoform, $N = 1.589$.

4. Apatite, $N_o = 1.634$. Positive moderate. $N > 1.59 < 1.66$.
   Limit: Enstatite, $N_m = 1.66\pm$. α-Monobromnaphthalene, $N = 1.65$–1.66.

5. Augite, $N_m = 1.71\pm$. Positive high. $N > 1.66 < 1.74$.
   Limit: Staurolite, $N_m = 1.741$–1.753. Methylene iodide, $N = 1.742$.

6. Zircon, $N_o = 1.93$–1.96. Positive very high. $N > 1.74 < 2.00$.
   Limit: Zincite, $N_o = 2.008$. Amorphous sulphur, $N = 1.998$.

7. Rutile, $N_o = 2.61\pm$. Positive extreme. $N > 2.00$.

Whenever an unknown mineral is in contact with any of the minerals or liquids which form the limits of this scale of refringence, so that a direct comparison of indices can be made by the method of vertical or inclined illumination, an accurate classification is possible even if the differences in the indices are very slight. For this purpose not only are the minerals and liquids named above available, but other common minerals and liquids which are near these limits may be used. The following table may be useful in this connection:

COMMON MINERALS NEAR THE LIMITS OF THE SCALE OF REFRINGENCE

Between 1 (negative distinct) and 2 (negative low):

Natrolite	N	$= 1.48\pm$	Cristobalite	N	$= 1.486$
Chabazite	N_m	$= 1.48\pm$	Analcite	N	$= 1.487$
Gmelinite	N_m	$= 1.48\pm$	Borax	N_g	$= 1.472$
Sodalite	N	$= 1.483$–1.487	Tridymite	N_g	$= 1.473$

Between 2 (negative low) and 3 (positive low):

Microcline	N_g	$= 1.529$	Quartz	N_o	$= 1.544$
Orthoclase	N_g	$= 1.526$	Oligoclase	N_m	$= 1.543$
Gypsum	N_g	$= 1.530$	Chalcedony	N_m	$= 1.537$
Albite	N_m	$= 1.529$	Nephelite	N_o	$= 1.536$–1.547
Anorthoclase	N_m	$= 1.529$	Cordierite	N_m	$= 1.543\pm$

Between 3 (positive low) and 4 (positive moderate):

Muscovite	$N_g = 1.59\pm$	Anorthite	$N_g = 1.585\pm$
Chlorite	$N_m = 1.57\text{–}1.62+$	Beryl	$N_o = 1.58\text{–}1.60$
Talc	$N_m = 1.58\text{–}1.59$	Scapolite ($Ma_{25}Me_{75}$)	$N_o = 1.59\pm$

Between 4 (positive moderate) and 5 (positive high):

Enstatite	$N_m = 1.66$	Forsterite	$N_m = 1.66$
Calcite	$N_o = 1.6585$	Gehlenite	$N_e = 1.658$
Sillimanite	$N_m = 1.66\pm$	Spodumene	$N_p = 1.65\text{–}1.67$
Tourmaline	$N_o = 1.668$ (average) 1.65–1.67 (blue and green)		

Between 5 (positive high) and 6 (positive very high):

Staurolite	$N_m = 1.74\text{–}1.75$	Chloritoid	$N_m = 1.74\pm$
Grossularite	$N = 1.735$	Rhodonite	$N = 1.73\text{–}1.76$
Hedenbergite	$N_m = 1.737$	Augite	$N_g = 1.71\text{–}1.73$
Epidote (of moderate birefringence)	$N_m = 1.74$ 1.75.		

Between 6 (positive high) and 7 (positive extreme):

Zincite	$N_o = 2.008$	Titanite	$N_g = 2.01\pm$
Cassiterite	$N_o = 1.997$	Sulphur	$N_m = 2.038$
Schorlomite	$N = 1.95\text{–}2.01$	Picotite	$N = 2.05\pm$

It is evident that an unknown mineral will not be found in contact with all these limit minerals. However, in thin sections, the unknown mineral is always immersed in Canada balsam, and the index of this substance is therefore commonly taken as a standard. If a mineral has a lower index than balsam its relief (and refringence) may be said to be negative, and, if higher, positive. Unfortunately balsam is rarely pure and therefore its index is not invariable; actual measurements have shown that it rarely passes the limits, 1.533 and 1.541; but, in order to be on the safe side, the tables include in the division of "negative low relief" minerals of indices up to 1.544 (= N_o in quartz), and in the division of "positive low relief" minerals of indices as low as 1.529 (= N_g in microcline). Even then there may be difficulty with sections prepared in the last few years since balsam dissolved in xylol has come into use, because such balsam may have an index less than that of orthoclase, perhaps even below 1.520. Therefore it is desirable to check the index of the balsam by a comparison with that of known minerals, especially potash feldspar.

It is believed that minerals can be classed accurately in this scale whenever they belong near the middle of one of the divisions, simply by comparing the relief of the unknown mineral with that of the various type minerals selected or with that of the minerals selected as limits. For this purpose the type minerals or the limit minerals may be sought in sections already available, or, more conveniently, the

type minerals or the limit minerals may all be mounted with the proper orientation to show the indices desired on a single slide. Such a slide would then serve as a standard for comparisons. When unknown minerals belong near a limit between two divisions of the scale of refringence a comparison of the relief is not sufficient to classify them accurately, and, if the unknown mineral is not in contact with a limit mineral (or substitute), and cannot be tested with a liquid, it may be necessary to assume that the mineral may belong in either one of the two divisions concerned.

So far as the refringence is concerned minerals are classified in the tables on the basis of N, N_o, or N_m. That is, the single index, N is used if the mineral is isotropic, the index of the ordinary ray, N_o, is used if the mineral is uniaxial, and the intermediate index, N_m, is used if the mineral is biaxial. This can lead to no difficulties with isotropic minerals. If the mineral is uniaxial, every grain or anhedron, in whatever position it may be, can be made to give the relief due to N_o simply by turning the stage to that position of extinction at which the vibration direction of the ordinary ray in the mineral coincides with the vibration direction of the lower nicol. Any position of a basal section may be used. If the mineral is biaxial every grain or anhedron has two indices of refraction; N_g' and N_p', such that $N_g' \geq N_m \geq N_p'$. That is, one index is always greater than, or equal to, N_m, and the other is always equal to, or less than, N_m. Every section or grain normal to an optic axis, and therefore having minimum birefringence, has two equal indices of refraction which are each equal to N_m. Any section or grain normal to a bisectrix or merely normal to the optic plane can be used to obtain N_m accurately, since it is only necessary to turn the mineral until the direction normal to the optic plane is parallel with the vibration direction of the lower nicol. Therefore, it is always possible to estimate, at least approximately, the value of N_m for an unknown biaxial mineral. If the birefringence of the unknown mineral is not great the relief of any grain or section in any position is sufficient to give a close approximation to the value of N_m; if the birefringence is strong or extreme it is important to study the relief in each extinction position, and on several grains or anhedra.

However, the most important advantage of using N, N_o and N_m in the tables is that their use makes it possible to estimate the refringence correctly without any preliminary study as to biaxial or uniaxial character. It is only necessary to select that grain or section which

shows the minimum interference color in order to obtain from it in any position the index which is used in the tables.

Of course, all minerals whose index of refraction varies (usually because of variation in composition) are entered in the tables in as many places as necessary to express the complete range of variation.

The main divisions in the table are based on the birefringence. For convenience in the use of this character the following scale has been employed.

SCALE OF BIREFRINGENCE

No. Mineral	Birefringence		Max. interf. colors in sections 0.03 mm. thick
1. Leucite.	Very weak.	N_g–N_p < 0.0035.	Dark grays.
2. Orthoclase.	Weak.	N_g–N_p > 0.0035 < 0.0095.	Gray and white } First order
3. Hypersthene.	Moderate.	N_g–N_p > 0.0095 < 0.0185.	Yellow and red } First order
4. Augite.	Rather strong.	N_g–N_p > 0.0185 < 0.0275.	Blue and green } Second order
5. Tourmaline.	Strong.	N_g–N_p > 0.0275 < 0.0365.	Yellow and red } Second order
6. Muscovite.	Very strong.	N_g–N_p > 0.0365 < 0.0545.	Blue to red. Third order
7. Titanite.	Extreme.	N_g–N_p > 0.0545.	Greenish and violet grays. Higher orders

Since all anisotropic minerals may be oriented so as to give the lowest interference colors, only the *maximum* birefringence is a property of determinative value, and it is necessary to assume that the maximum interference color can be obtained from the given unknown mineral (or, at least, a color near the maximum). In the case of minerals whose (maximum) birefringence varies with variation in composition, as in hornblende and epidote, the names are entered in as many subdivisions as necessary to express the complete range of variation.

The second table is based primarily upon birefringence and secondarily upon refringence. The fifty six groups thus established are subdivided still further on the basis of color and crystallization for the groups dealing with isotropic minerals and on the basis of optic sign, cleavages, elongation, extinction directions with respect to elongation or cleavages and color. For the purposes of this table cleavages are not considered to be "visible" unless they are described as "perfect" or are known to be readily observed in thin section. Thus, the "distinct" cleavage of olivine is so difficult of observation in thin section that it is not considered "visible."

The third table which follows, like the second, is designed primarily for use in connection with the study of thin sections. It is based,

first, on the color and pleochroism of minerals in thin sections, and secondarily upon the birefringence. In each subdivision, thus formed, the minerals are arranged in the order of increasing refringence. Of course, minerals vary in color; they are entered in the table in as many places as necessary to express all these variations, so far as known; but too much reliance should not be put on color alone as a means of identifying minerals. The table may, nevertheless, be useful as a means of suggesting possibilities in many cases.

The fourth and fifth tables are designed primarily for use with powders and immersion liquids, though the fourth table can also be used to good advantage under favorable circumstances in the study of thin sections. The fourth table is based primarily upon the refringence of minerals. It is divided into two parts, the first one including the isotropic minerals and the second one including the anisotropic minerals. In each part the minerals are arranged in the order of increasing refringence and all known variations in refringence are shown by means of vertical lines at the right of the column of indices. In the second part of the table positive minerals are distinguished from negative ones by indenting the indices of refraction of negative minerals two spaces to the right.

The fifth table is based primarily on the dispersion of minerals, that is, on the difference in index of refraction (N, N_o or N_m) in light of the *F* line wave-length and light of the *C* line wave-length. In each group, thus established, the minerals are arranged in the order of increasing refringence. This table is intended for use with powdered minerals and immersion liquids. It presents all available data, but is remarkably incomplete.

Neither the relative abundance nor the relative importance of minerals can be measured quantitatively; both are matters of estimate and vary with time and place. Nevertheless, minerals vary so greatly in these respects that it seems worth while to express this variation, even though the expression be only the author's estimate of the condition. For this purpose the names of minerals in the tables are set in different styles of type, as follows:

1. Bold-face capital letters are used for very common minerals, like quartz, calcite and orthoclase, and also for a few very important minerals like nephelite.

2. Bold-face lower case letters are used for common minerals, like tremolite, rutile, tourmaline, etc., and also for a few important minerals, like analcite, andalusite and cordierite.

3. Ordinary Roman type is used for less common minerals, like chabazite, humite and pectolite, and also for minerals quite abundant or important in rare rocks, ores and other unusual mineral aggregates, such as aegirite, arsenopyrite, diamond, galena, halite, malachite, etc.

4. Italic type is used for many very rare minerals, such as agricolite, cervantite and hillebrandite.

TABLE I.—OPAQUE MINERALS

The petrographic microscope is not well adapted to the study of minerals which are opaque in thin section; therefore only those few of the commonest opaque minerals are included in the following table which were included in Part II of this work. No one working with the petrographic microscope should expect to identify an opaque mineral with certainty unless it has a *characteristic* color in reflected light, a condition which is quite rare. Nevertheless, the commoner opaque minerals can be recognized with a high degree of probability in many cases, and the table of opaque minerals will assist in this work. For accurate study of opaque minerals special mineragraphic microscopes should be used and the samples should not be mounted in thin sections, but very highly polished on one uncovered side. For more complete directions for such work reference may be made to the works of Murdoch, Davy and Farnham, Schneiderhöhn and van der Veen.

Minerals which are always opaque in thin sections are included in the following table, and, in general, not included in the other tables; minerals which are subtranslucent to opaque in thin section are included for convenience both in the following table and in the other tables, so far as known data permit.

The page references in the following table refer to the third edition of Part II of this work.

TABLE I.—OPAQUE MINERALS

MINERALS, WHICH ARE OPAQUE BECAUSE OF AGGREGATE EFFECTS, LIKE LEUCOXENE, SOME LIMONITE, GLAUCONITE, ETC., ARE NOT INCLUDED HERE

1. Always opaque in thin sections of standard thickness

Color in Reflected Light	Cleavage	System	Mineral	Chemical	Other Characters	Page
Steel blue	111 part.	Isom.	**MAGNETITE**	Fe_3O_4	Magnetic. Common	63
	None	Rhom.	**Ilmenite**	$FeTiO_3$	Alters to leucoxene	66
	None	Rhom.	**HEMATITE**	Fe_2O_3	Oxidation product	44
Iron black to steel gray	111 part.	Isom.	*Franklinite*	Ox.	In rare ores	63
	None	Isom.	**Chromite**	$FeCr_2O_4$	Oct. In ign. rocks	62
	100 perf.	Isom.	*Iron*	Fe	Very magnetic. Rare	16
	?	Isom.	*Ulrichite*	UO_2?	In veins and pegmatites	68
	?	Isom.	*Metacinnabarite*	HgS	Unstable. Rare	21
	001 dist.	Tet.	*Hausmannite*	Mn_3O_4	In ores. Rare	64
	111 perf.	Tet.	*Braunite*	Mn_2O_3	In ores. Rare	66
	0001 perf.	Hex.	Graphite	C	Very soft. Uncommon	14
	100 dist.	Orth.	Columbite	Colum.	In pegmatite. Rare	165
	110 perf.	Orth.	*Enargite*	Cu_3AsS_4	In Cu ores. G.=4.4	28
	010 perf.	Mon.	Wolframite	Tung.	In veins and pegmatites	101
Lead gray	100 perf.	Isom.	**Galena**	PbS	In veins, contacts, etc.	19
	None	Isom.	*Argentite*	Ag_2S	In veins. Rare	19
	0001 perf.	Hex.	Molybdenite	MoS_2	In veins and pegmatites	26
	001, 100	Orth.	Chalcocite	Cu_2S	In veins, etc. Rare	18
Silver white	110 dist.	Orth.	Arsenopyrite	FeAsS	In veins, etc. Rare	24
Silver white	None	Isom.	*Silver*	Ag	In veins, etc. Rare	16
Gold yellow	None	Isom.	*Gold*	Au	In veins, placers, etc.	16
Brass yellow	None	Isom.	**Pyrite**	FeS_2	G.=5. Widely distributed	22

Brass yellow, dark	None	Tet.	Chalcopyrite	$CuFeS_2$	In veins, etc.	26
Bronze yellow	0001 poor	Hex.	**Pyrrhotite**	FeS	Magnetic. Not rare	21
Bronze yellow	110 dist.	Orth.	Marcasite	FeS_2	In coal, veins, etc.	24
Copper red	None	Isom.	*Copper*	Cu	In veins, etc. Rare	16
Copper red, brownish	None	Isom.	*Bornite*	Cu_5FeS_4	In veins, etc. Rare	26
Copper red, pale	None	Hex.	*Niccolite*	$NiAs$	In veins, etc. Rare	20
Deep red	None	Rhom.	**HEMATITE**	Fe_2O_3	Oxidation product	44
Indigo blue	0001 perf.	Hex.	*Covellite*	CuS	In veins, etc. Rare	20

2. Subtranslucent to opaque in thin section. In reflected light most of the following minerals are steel gray; hematite is usually red, but specularite is like steel in reflected light

Color in Transmitted Light						
Red, cherry	None	Isom.	Tetrahedrite	$Cu_6Sb_2S_6$	Splendent luster. Rare	26
Red, dark	None	Isom.	*Magnesioferrite*	$MgFe_2O_4$	About volcanoes. Rare	61
Red, brownish	None	Isom.	**Chromite**	$FeCr_2O_4$	Oct. In ign. rocks	62
Red, dark	110 dist.	Tet.	**Rutile**	TiO_2	Sparse, but not rare	50
Red, brownish	001 perf.	Tet.	*Heterolite*	$ZnMn_2O_4$	In ores. Rare	65
Red, blood	None	Rhom.	**HEMATITE**	Fe_2O_3	Oxidation product	44
Red, dark	010 perf.	Orth.	Stibnite	Sb_2S_3	In veins, etc. Rare	25
Red, dark	100 dist.	Orth.	*Tantalite*	Tant.	In pegmatites, etc.	165
Red, dark	010 poor	Mon.	*Miargyrite*	$AgSbS_2$	In veins, etc. Rare	27
Red, blood	None	Mon. ?	*Arizonite*	Ox. ?	In pegmatite. Rare	68
Brown	None	Tet.	*Plattnerite*	PbO_2	In oxide zone of veins	53
	001 dist.	Tet.	*Hausmannite*	Mn_3O_4	In ores. Rare	64
	010 poor	Orth.	*Samarskite*	Colum.	In pegmatites. Rare	166
	?	Orth.	*Hjelmite*	Tant.	In pegmatites. Rare	166
Brown or green	100	Isom.	*Dysanalite*	Tit.	In contacts, etc. Rare	163
	001, 010	Orth.	Ilvaite	Sil.	In contacts, etc. Rare	431
	001 perf.	Mon.	Cronstedtite	Sil.	In ores, etc. Not common	285

TABLE II.—BIREFRINGENCE OF MINERALS

In thin section it is usually possible to estimate the birefringence of any unknown mineral at least approximately by means of its maximum interference color and a measure or estimate of the thickness of the section. Therefore a determinative table based primarily on the birefringence is highly desirable. It is true that the chart of birefringences (Plate I) is based on the same property, but the colored chart shows only the rock-forming minerals and is therefore incomplete and unsatisfactory when studying ores and other uncommon mineral aggregates. Furthermore, the colored chart shows only the birefringence of minerals, while the following table of birefringence serves to identify the minerals also by means of their refringence, cleavage, color, crystal form, optic sign, optic angle, optic orientation, etc.

Many minerals vary more or less in their chemical composition and therefore in their physical properties, including their birefringence. Each mineral is entered in the tables in as many places as necessary to express all variations in its properties, so far as they are known.

For methods of estimating or measuring the birefringence of minerals, see the fifth edition of Part I, pages 116–124 and 135–137.

For methods of estimating or measuring the refringence of minerals, see Part I, pages 75–85 and (for minerals in powder form) pages 228–239 and 248–253.

For a discussion of cleavage, see Part I, pages 29–32. For the purposes of this table cleavages are not considered to be "visible" unless they are known to be observed readily in thin section or are described as "perfect."

For a discussion of color and absorption, see Part I, pages 55–56.

For methods of determining pleochroic formulas, see Part I, pages 170, 171, 204, and 211.

For definitions of X, Y and Z, see Part I, pages 117 and 160.

For methods of distinguishing between X, Y and Z, see Part I, pages 124, 130, 137, and 211.

For a discussion of crystal forms and crystal systems, see Part I, pages 2–26.

For methods of determining the optic sign, see Part I, pages 129–132, 138, 148–154, 169, and 206–213.

For methods of estimating or measuring the optic axial angle, see Part I, pages 186–189, 211, 226, and 245.

For methods of determining the optic orientation of a mineral, see Part I, pages 170, 171, 205, and 212.

For methods of measuring extinction angles, see Part I, pages 126, 137, 173, 174, and 178.

For a list of abbreviations and symbols used in the table see page xiii.

The last column in the table gives the page of the third edition of Part II of this work on which a more complete description of each mineral may be found.

Success in using the table is absolutely dependent upon accuracy in assigning an unknown mineral to the subdivision to which it belongs; therefore the following outline classification should be used with the utmost care.

Birefringence. (N_g-N_p)	Optic Sign	Refringence (N, N_o or N_m)						
		<1.48	>1.48 <1.54	>1.53 <1.59	>1.59 <1.66	>1.66 <1.74	>1.74 <2.00	>2.00
		Group	Group	Group	Group	Group	Group	Group
0.000		1	2	3	4	5	6	7
<0.0035	+	8	9a	10a	11a	12	13	14
	−		9b	10b	11b			
>0.0035 <0.0095	+	15a	16a	17a	18a	19a	20a	21
	−	15b	16b	17b	18b	19b	20b	
>0.0095 <0.0185	+	22a	23a	24a	25a	26a	27a	28a
	−	22b	23b	24b	25b	26b	27b	28b
>0.0185 <0.0275	+	29a	30a	31a	32a	33a	34a	35a
	−	29b	30b	31b	32b	33b	34b	35b
>0.0275 <0.0365	+	36	37a	38a	39a	40a	41a	42
	−		37b	38b	39b	40b	41b	
>0.0365 <0.0545	+	43	44a	45a	46a	47a	48a	49a
	−		44b	45b	46b	47b	48b	49b
>0.0545	+	50	51a	52a	53a	54a	55a	56a
	−		51b	52b	53b	54b	55b	56b

TABLE II.—BIREFRINGENCE OF MINERALS

O. Birefringence zero: $N_g - N_p = 0.000$

Cleavage, Optic Orient.	Habit, etc.	Color	N	Mineral	Chem.	Other Characters	Page
				Group 1. Refringence negative and distinct: $N < 1.48$			
				A. Uncolored in thin section and not isometric			
None	Clay	Colorless	1.40?	*Termierite*	Sil.	G.=1.2? Sol. HCl	415
None	Mass.	Colorless	1.41–6	**Opal**	Ox.	G.=2.1. Sol. HF or KOH	57
None	Vit.	Colorless	1.458	*Lechatelierite*	SiO_2	G.=2.2. Sol. HF	57
None	Clay	Colorless	1.47–9	***Allophane***	Sil.	G.=1.87. Gel. HCl	415
None	Clay	Colorless	1.47–1.57	Halloysite	Sil.	G.=2.1. Sol. HF	415
				B. Uncolored in thin section and isometric			
111 perf.	Oct.	Colorless	1.339	*Hieratite*	Hal.	G.=2.75. Sol. H_2O	36
110 perf.	Oct.	Colorless	1.339	*Cryolithionite*	Hal.	G.=2.78. Sol. H_2O	34
None	Oct.	Colorless	1.427	*Ralstonite*	Hal.	Also biref. with 2V=Lg.	36
111 perf.	Cub.	Colorless	1.434	Fluorite	CaF_2	G.=3.18. Sol. H_2SO_4	31
111	Gran.	Colorless	1.435–1.45	*Yttrofluorite*	Hal.	Color fades in light	35
?	Cub.	Colorless	1.45–6	*Melanophlogite*	SiO_2	Black on heating	54
None	Dodec.	Colorless	1.454	***Sulfohalite***	Sul.	G.=2.5. Sol. H_2O	118
None	Isom.	Colorless	1.456	Potassalumite	Sul.	G.=1.76. Sol. H_2O	113
None	Fib.	Colorless	1.457	*Tschermigite*	Sul.	G.=1.64. Sol. H_2O	113
111 dist.	Oct.	Colorless	1.48	*Faujasite*	Sil.	Also biref. Gel. HCl	382
001 diff.	Trap.	Colorless	1.48–9	**Analcite**	Sil.	Also biref. Gel. HCl	293
				C. Colored in thin section			
111 perf.	Cub.	Tinted ±	1.434	Fluorite	CaF_2	G.=3.18. Sol. H_2SO_4	31
111 poor	Gran.	Violet	1.435	*Yttrocerite*	Hal.	G.=3.5. Sol. HCl	36

111	Gran.	Yel., gr.	1.435–1.45	*Yttrofluorite*	Hal.	Color fades in light	35
?	Cub.	Yellow ±	1.45–6	*Melanophlogite*	SiO_2	Black on heating	54
None	Mass.	Yel., br.	1.45–7	*Hisingerite*	Sil.	G. = 3. Dec. HCl	415
None	Mass.	Brown	1.47?	*Neotocite*	Sil.	G. = 2.7. Dec. HCl	413

Group 2. Refringence negative and low: $N > 1.48 < 1.54$

A. Uncolored in thin section and not isometric

None	Clay	Colorless	1.47–9	***Allophane***	Sil.	G. = 1.87. Gel. HCl	415
None	Conch.	Colorless	1.485	*Evansite*	Phos.	G. = 1.94. Sol. H_2SO_4	145
None	Mass.	Colorless	1.49+	*Vashegyite*	Phos.	G. = 1.96. Sol. HCl	144
None	Mass.	Colorless	1.50±	*Stevensite*	Sil.	Alter. of pectolite	419
None	Mass.	Colorless	1.50±	*Montmorillonite*	Sil.	G. = 2.±	434
None	Mass.	Colorless	1.517	*β-Sepiolite*	Sil.	G. = 2.	410
None	Mass.	Colorless	1.517	*Planerite*	Phos.	G. = 2.65. Dec. HCl	145
None	Mass.	Colorless	1.53	*Kehoeite*	Phos.	G. = 2.34. Sol. HCl	158
None	Mass.	Colorless	1.53±	*Spadaite*	Sil.	Pearly luster. Gel. HCl	413

B. Uncolored in thin section and isometric

111 dist.	Oct.	Colorless	1.48	*Faujasite*	Sil.	Also biref. Gel. HCl	382
100 diff.	Trap.	Colorless	1.48–9	**Analcite**	Sil.	Also biref. Gel. HCl	293
100 poor	Dodec.	Colorless	1.485	**Sodalite**	Sil.	G. = 2.14–2.4. Gel. HCl	289
?	Oct.	Colorless	1.486	*Metacristobalite*	SiO_2	G. = 2.27. Sol. HF	54
100 perf.	Cub.	Colorless	1.49	Sylvite	KCl	G. = 1.98. Sol. H_2O	30
100 poor	Trap.	Colorless	1.508	**LEUCITE**	Sil.	G = 2.47. Dec. HCl	291
None	Oct.	Colorless	1.508	*Tychite*	Sul.	G. = 2.5. Sol. HCl	118
None	Oct.	Colorless	1.514	*Northupite*	Carb.	Also biref. G. = 2.38	85
None	Cub.	Colorless	1.525	*Pollucite*	Sil.	G. = 2.9. Dec. HCl	293
?	Tetar.	Colorless	1.535	*Langbeinite*	Sul.	G = 2.83. Sol. H_2O	110

TABLE II.—BIREFRINGENCE OF MINERALS

O. Birefringence zero: $N_g - N_p = 0.000$—*continued*

Cleavage, Optic Orient.	Habit, etc.	Color	N	Mineral	Chem.	Other Characters	Page
				Group 2. Refringence negative and low: N>1.48<1.54—*continued*			
				C. Colored in thin section			
110 poor	Dodec.	Blue, etc.	1.48–9	Noselite	Sil.	G.=2.3. Gel. HCl	290
110 poor	Dodec.	Yel., bl., red	1.485	**Sodalite**	Sil.	G.=2.14–2.4. Gel. HCl	289
110 poor	Dodec.	Violet	1.487	Hackmanite	Sil.	G.=2.4 Gel. HCl	290
110 poor	Dodec.	Blue, etc.	1.49–1.51	Hauynite	Sil.	G=2.4. Gel. HCl	290
110 poor	Dodec.	Blue	1.50±	Lazurite	Sil.	G.=2.4. Gel. HCl	290
None	Coll.	Yellow	1.5±	*Rosiéresite*	Phos.	G.=2.2. Sol. HNO_3	145
None	Coll.	Bl., br.	1.525–1.55	*Cornuite*	Sil.	G.=2. Opaline. Sol. HCl	413
None	Coll.	Yellow	1.53–4	*Succinite*	C, H	G.=1.07. Sol. alcohol	89
None	Mass.	Brown	1.53–7	*Neotocite*	Sil.	G.=2.7. Dec. HCl	413
				Group 3. Refringence positive and low: N>1.53<1.59			
				A. Uncolored in thin section			
None	Mass.	Colorless	1.53	*Kehoeite*	Phos.	G.=2.34. Sol. HCl	158
None	Mass.	Colorless	1.53±	*Spadaite*	Sil.	Pearly luster. Gel. HCl	413
?	Tet'h	Colorless	1.535	*Langbeinite*	Sil.	G.=2.83. Sol. H_2O	110
100 perf.	Cub.	Colorless	1.544	Halite	Hal.	G.=2.17. Sol. H_2O	29
None	Mass.	Colorless	1.55	*Montmorillonite*	Sil.	G.=2.±	434
None	Mass.	Colorless	1.555	*Collyrite*	Sil.	G.=2.±. F.=7.	435
None	Mass.	Colorless	1.56–1.61	Bauxite	Ox.	G.=2.55. Sol. H_2SO_4	49
?	Tet'h.	Pink	1.57	*Manganolangbeinite*	Sul.	G.=3. Sol. H_2O	110
None	Mass.	Colorless	1.57–1.62	Collophane	Phos.	G.=2.6–2.9. Sol. HNO_3	161
None	Mass.	Colorless	1.584	*Schroetterite*	Sil.	G.=2.±	415

111	Tet'h.	Colorless	1.59±	*Zunyite*	Sil.	G.=2.87. Sol. HF	414
?	Cub.	Colorless	1.59	*Kochite*	Sil.	G.=2.93	414

B. Colored in thin section

None	Coll.	Bl. or br.	1.525–1.55	*Cornuite*	Sil.	G.=2. Opaline. Sol. HCl	413
None	Coll.	Yellow	1.53–4	*Succinite*	C, H	G.=1.07. Sol. alcohol	89
None	Mass.	Brown	1.53–1.7	**Allanite**	Sil.	G.=3.±. Gel. HCl	316
None	Coll.	Brown	1.53–7	*Neotocite*	Sil.	G.=2.7. Dec. HCl	413
001 perf.	Lam.	Green	1.55–1.68	**Chlorite**	Sil.	G.=2.6–3.0. Dec. HCl	276
None	Mass.	Green	1.56–1.61	*Zaratite*	Carb.	G.=2.6±. Sol. HCl	85
None	Mass.	Brown	1.57–1.67	*Borickite*	Phos.	G.=2.7±. Sol. HCl	157
None	Mass.	Brown	1.57±	*Hisingerite*	Sil.	G.=3. Dec. HCl	415
None	Mass.	Green	1.59	*Garnierite*	Sil.	G=2.5±. Dec HCl	261

Group 4. Refringence positive and moderate: $N > 1.59 < 1.66$

A. Uncolored in thin section

?	Cub.	Colorless	1.59	*Kochite*	Sil.	G.=2.93	414
None	Mass.	Colorless	1.6–1.87	*Stibiconite*	Ox.	G.=5.2±. Also biref.	68
0001 dist.	Var.	Colorless	1.607	*Eudialite*	Sil.	Colored in mass. G.=3±	417
None	Mass.	Colorless	1.62–1.70	*Diadochite*	Sul.	Opaline	121
111 poor	Cub.	Colorless	1.642	*Salammoniac*	NH_4Cl	G.=1.53. Sol. H_2O	30

B. Yellow in thin section

None	Mass.	Orange	1.59±	*Hisingerite*	Sil.	G.=3. Dec. HCl	415
None	Mass.	Yellow	1.61±	*Gummite*	Ox.	G.=4±. Sol. HCl	68
None	Mass.	Yellow±	1.62–1.70	*Diadochite*	Sul.	Opaline	121
None	Mass.	Yel., br.	1.63–5	*Griphite*	Phos.	G.=3.4. Sol. HCl	155
None	Mass.	Yellow	1.64	*Picite*	Phos.	G.=2.83	145
None	Mass.	Yellow	1.64±	*Lagonite*	Bor.	Earthy	94
None	001	Yellow±	1.64	*Homilite*	Sil.	Also biref. G.=3.3±	424
None	Mass.	Yel., gr.	1.65	*Greenalite*	Sil.	G.=2.8+. Sol. HCl	413

TABLE II.—BIREFRINGENCE OF MINERALS

O. Birefringence zero: $N_g - N_p = 0.000$—*continued*

Cleavage, Optic Orient.	Habit, etc.	Color	N	Mineral	Chem.	Other Characters	Page
			Group 4. Refringence positive and moderate: $N > 1.59 < 1.66$—*continued*				
			C. Brown in thin section				
None	Mass.	Brown	1.53–1.7	**Allanite**	Sil.	G.=3±. Gel. HCl	316
None	Mass.	Brown	1.57–1.67	*Borickite*	Phos.	G.=2.7±. Sol. HCl	157
None	Mass.	Brown	1.59±	*Hisingerite*	Sil.	G.=3. Dec. HCl	415
None	Mass.	Br., yel.	1.63–5	*Griphite*	Phos.	G.=3.4. Sol. HCl	155
None	Mass.	Red-br.	1.635	*Pitticite*	Sul.	G.=2.2–2.5. Sol. HCl	121
None	Mass.	Br., gr.	1.65	*Greenalite*	Sil.	G.=2.8+. Sol. HCl	413
			D. Green in thin section				
001 perf.	Lam.	Green	1.55–1.68	**Chlorite**	Sil.	G.=2.6–3.0. Dec. HCl	276
None	Mass.	Green	1.59	*Garnierite*	Sil.	G.=2.5±. Dec. HCl	261
?	Oct.	Green	1.60±	*Voltaite*	Sul.	G.=2.75. Sol. HCl	115
None	Mass.	Gr., br.	1.65	*Greenalite*	Sil.	G.=2.8+. Sol. HCl	413
			Group 5. Refringence positive and high: $N > 1.66 < 1.74$				
			A. Uncolored in thin section				
None	Mass.	Colorless	1.6–1.87	*Stibiconite*	Ox.	G.=5.2±. Also biref.	68
None	Oct.	Colorless	1.67±	*Hibschite*	Sil.	Also biref. G.=3. Sol. HCl	429
None	Dodec.	Colorless	1.675	*Plazolite*	Sil.	G.=3.1	183
111 poor	Tet'h.	Colorless	1.694	*Rhodizite*	Bor.	Also biref. G.=3.35	94
None	Isom.	Tinted ±	1.71+	**Pyrope**	Sil.	G.=3.6±. Insol.	178
None	?	Colorless	1.727	*Berzelite*	Arsen.	G.=4. Sol. HNO_3	122
111 poor	Oct.	Tinted ±	1.73±	Spinel	Ox.	G.=3.6. Sol. H_2SO_4	62
None	Dodec.	Colorless	1.735+	**Grossularite**	Sil.	G.=3.5±. Insol.	180

100 perf.	Cub.	Colorless	1.735±	*Perciclase*	MgO	G. = 3.65. Sol. HCl	41
None	Mass.	Colorless	1.74±	*Pilbarite*	Ox.	G. = 4.6. Sol. HCl	185
				B. Yellow, brown, or red in thin section			
None	Mass.	Brown	1.53–1.7	**Allanite**	Sil.	G. = 3±. Gel. HCl	316
None	Mass.	Brown	1.57–1.67	*Borickite*	Phos.	G. = 2.7±. Sol. HCl	157
110 ?	Tet.	Yel., br.	1.68–1.72	*Thorite*	Ox.	Also biref. G. = 5±	185
110 poor	Cub.	Yellow ±	1.69	*Pharmacosiderite*	Phos.	G. = 3.0. Sol. HCl	143
None	Orth.	Brown	1.70	*Polycrase*	Colum.	G. = 5.0. Dec. H_2SO_4	167
None	Isom.	Br., red	1.71±	**Pyrope**	Sil.	G. = 3.6±. Insol.	178
None	Mass.	Br., yel.	1.72	*Delvauxite*	Phos.	G. = 1.9±. Concretions	145
111 poor	Oct.	Red, etc.	1.73±	Spinel	Ox.	G. = 3.6. Sol. H_2SO_4	62
None	Rhom.	Yel., br.	1.73–1.76	*Tritomite*	Sil.	G. = 4.3. Dec. HCl	420
None	Dodec.	Yel.-red	1.735+	**Grossularite**	Sil.	G. = 3.5±. Insol.	180
111 poor	Tet'h	Pink	1.737	*Danalite*	Sil.	G. = 3.4. Gel. HCl	291
111 poor	Tet'h.	Yellow	1.739	*Helvite*	Sil.	G. = 3.2. Gel. HCl	291
None	Rhom.	Yel.-br.	1.74±	*Caryocerite*	Sil.	G. = 4.3. Dec. HCl	420
				C. Green or blue in thin section			
001 perf.	Lam.	Green	1.55–1.68	**Chlorite**	Sil.	G. = 2.6–3.0. Dec. HCl	276
100 poor	Cub.	Green	1.69	*Pharmacosiderite*	Phos.	G. = 3.0. Sol. HCl	143
None	Isom.	Green	1.725	*Rowlandite*	Sil.	G. = 4.5. Gel. HCl	420
111 poor	Oct.	Blue, green	1.73±	Spinel	Ox.	G. = 3.6. Sol. H_2SO_4	62
				Group 6. Refringence positive and very high: $N > 1.74 < 2.00$			
				A. Uncolored in thin section and not isometric			
None	Mass.	Colorless	1.6–1.87	*Stibiconite*	Ox.	G. = 5.2. Also biref.	68
None	Mass.	Colorless	1.74	*Pilbarite*	Ox.	G. = 4.6. Sol. HCl	185
None	Tet.	Colorless	1.77	*Mackintoshite*	Ox.	G. = 5.4. Sol. HCl	185
None	Tet.	Colorless	1.82–1.93	Malacon	Ox.	G. = 4±. Dec. H_2SO_4	184
None	Var.	Colorless	1.88–2.06	*Cervantite*	Ox.	G. = 4. Sol. HCl	67

TABLE II.—BIREFRINGENCE OF MINERALS

O. Birefringence zero: $N_g - N_p = 0.000$—*continued*

Cleavage, Optic Orient.	Habit, etc.	Color	N	Mineral	Chem.	Other Characters	Page
				Group 6. Refringence positive and very high: $N > 1.74 < 2.00$—*continued*			
				B. Uncolored in thin section and isometric			
111 poor	Oct.	Tinted±	1.74±	Spinel	Ox.	G.=3.6. Sol. H_2SO_4	62
None	Dodec.	Tinted±	1.74±	**Grossularite**	Sil.	G.=3.5±. Insol.	180
None	Oct.	Colorless	1.755	*Arsenolite*	As_2O_3	G.=3.7. Sol. H_2O	43
None	Oct.	Tinted±	1.87±	*Chalcolamprite*	Colum.	G.=3.77. Insol.	164
None	Oct.	Tinted±	1.92±	*Betafite*	Tit.	G.=4. Insol.	164
None	Oct.	Tinted±	1.92–1.96	*Samirésite*	Colum.	G.=5.24. Insol.	164
None	Oct.	Colorless	1 93	*Microlite*	Tant.	G.=5.5. Insol.	164
100	Cub.	Colorless	1.93	*Nantokite*	CuCl	G.=3.93. Sol. H_2O	30
None	Oct.	Colorless	1.95–1.99	*Neotantalite*	Tant.	G.=5.2. Insol.	164
None	Oct.	Tinted±	1.98±	*Hatchettolite*	Colum.	G.=4.8±. Insol.	164
				C. Yellow in thin section			
111 poor	Oct.	Yel., red, etc.	1.74±	Spinel	Ox.	G.=3.6. Sol. H_2SO_4	62
None	Dodec.	Yellow±	1.74±	**Grossularite**	Sil.	G.=3.5±. Insol.	180
None	Rhom.	Yel., brown	1.74±	*Caryocerite*	Sil.	G.=4.3. Dec. HCl	420
100	Cub.	Yel.-br.	1.812	*Beckelite*	Sil.	G =4.1. Sol. HCl	420
111	Oct.	Yellow	1.82–7	*Roméite*	Antim.	G.=5. Insol.	159
111	Oct.	Yel., br.	1.96–2.02	*Pyrochlore*	Tit.	G.=4.3. Dec. H_2SO_4	163
None	Orth.	Br., yel.	2.0±	*Wiikite*	Colum.	G.=3.8–4.8. Insol.	167
				D. Brown in thin section			
111 poor	Oct.	Br., red, etc.	1.74±	Spinel	Ox.	G.=3.6. Sol. H_2SO_4	62
None	Dodec.	Brown±	1.74±	**Grossularite**	Sil.	G.=3.5±. Insol.	180

None	Rhom.	Yel., br.	1.74±	*Caryocerite*	Sil.	G.=4.3. Dec. HCl	420
None	?	Brown	1.77	*Melanocerite*	Sil.	G.=4±. Sol. HCl	420
None	Dodec.	Br., red	1.78–1.83	**Almandite**	Sil.	G.=4.2±. Insol.	178
None	Prism.	Gr., br.	1.78±	Gadolinite	Sil.	G.=4±. Gel. HCl	424
111 fair	Oct.	Gr., bl., br.	1.79–1.81	*Gahnite*	Ox.	G.=4.5±. Sol. H_2SO_4	63
None	Oct.	Brown	1.8±	*Manganspinel*	Ox.	G.=4. Insol.	62
None	Tet.	Gr., br.	1.82	*Naegite*	Ox.	G.=4.1. Insol.	65
None	Mass.	Gr., br.	1.86±	*Bindheimite*	Antim.	G.=4.6. Insol.	160
None	Dodec.	Br., red	1.86–2.01	Schorlomite	Sil.	G.=3.7–3.9. Insol.	183
111	Oct.	Yel., br.	1.96–2.02	*Pyrochlore*	Tit.	G.=4.3. Dec. H_2SO_4	159
None	Orth.	Br., yel.	2.0±	*Wiikite*	Colum.	G.=3.8–4.8. Insol.	167

E. Red in thin section

111 poor	Oct.	Red, br., etc.	1.74±	Spinel	Ox.	G.=3.6. Sol. H_2SO_4	62
None	Dodec.	Red	1.76–1.82	Rhodolite	Sil.	G.=3.8. Insol.	178
None	Dodec.	Red, br.	1.77–1.81	**Spessartite**	Sil.	G.=4±. Insol.	178
None	Dodec.	Red, br.	1.78–1.83	**Almandite**	Sil.	G.=4.2±. Insol.	178
None	Dodec.	Red, br.	1.85–1.89	**Andradite**	Sil.	G.=3.7–4.1. Insol.	180
None	Dodec.	Red, br.	1.86–2.01	Schorlomite	Sil.	G.=3.7–3.9. Insol.	183

F. Green or blue in thin section

111 poor	Oct.	Gr., red, etc.	1.74±	Spinel	Ox.	G.=3.6. Sol. H_2SO_4	62
None	Orth.	Green	1.758	*Yttrialite*	Sil.	G.=4.6. Sol. HCl	414
None	Isom.	Green	1.77–1.80	*Hercynite*	Ox.	G.=3.9. Insol.	62
None	Prism.	Gr., br.	1.78±	Gadolinite	Sil.	G.=4±. Gel. HCl	424
111 fair	Oct.	Gr., bl., br.	1.79–1.81	*Gahnite*	Ox.	G.=4.5±. Sol. H_2SO_4	63
None	Tet.	Gr., br.	1.82	*Naegite*	Ox.	G.=4.1. Insol.	65
None	Mass.	Gr., br.	1.86±	*Bindheimite*	Antim.	G.=4.6. Insol.	160
None	Dodec.	Green	1.87±	*Uvarovite*	Sil.	G.=3.7. Insol.	180

TABLE II.—BIREFRINGENCE OF MINERALS

O. BIREFRINGENCE ZERO: $N_g - N_p = 0.000$

Cleavage, Optic Orient.	Habit, etc.	Color	N	Mineral	Chem.	Other Characters	Page
				Group 7. Refringence positive and extreme: $N > 2.00$			
				A. Uncolored in thin section			
110 poor	Tet'h.	Colorless	2.05	*Eulytite*	Sil.	G.=6.1. Gel. HCl	414
None	Mass.	Gray, etc.	2.06–2.25	*Cerargyrite*	Hal.	G.=5.4–6. Sol. NH_4OH	30
None	Oct.	Colorless	2.065	*Mosesite*	Hal.	Also biref. Soft	34
111 poor	Oct.	Colorless	2.087	*Senarmontite*	Sb_2O_3	G.=5.2. Sol. HCl	43
?	Mass.	Colorless	2.15–2.28	*Bismutite*	Carb.	G.=7.0. Sol. HNO_3	86
111 dist.	Isom.	Colorless	2.20	*Lewisite*	Antim.	G.=4.95. Insol.	162
111 perf.	Isom.	Tinted±	2.42	Diamond	C	G.=3.5. H.=10. Insol.	13
				B. Yellow in thin section			
None	Mass.	Yellow	2.0–2.1	**Limonite**	Ox.	G.=3.8±. Sol. HCl	47
?	Orth.?	Yel., br.	2.0±	*Wiikite*	Colum.	G.=3.8.–4.8. Insol.	167
111 dist.	Oct.	Yellow	2.09	*Schneebergite*	Antim.	G.=5.4.	160
?	Orth.	Amber	2.12–2.15	*Yttrocrasite*	Tit.	G.=4.8. Sol. H_2SO_4	167
110	Tet'h.	Yellow	2.20	*Miersite*	Hal.	G.=5.64. Sol. NH_4OH	30
?	Isom.	Yellow	2.21	*Weslienite*	Antim.	G.=4.97	160
100	Cub.	Yel., br.	2.33	*Dysanalite*	Tit.	G.=4.1. Dec. HCl	163
110	Tet'h.	Yellow	2.35	*Marshite*	CuI	G.=5.59. Extr. disp.	30
110 perf.	Tet'h.	Yel., br.	2.37–2.47	Sphalerite	ZnS	G.=4±. Sol. HCl	19
111 perf.	Isom.	Tinted±	2.42	Diamond	C	G.=3.5. H.=10. Insol.	13
None	Dodec.	Yellow	2.49	*Eglestonite*	Hal.	G.=8.3. Dec. HCl	37

C. Brown in thin section and not isometric

?	Orth.?	Br., yel.	2.0±	*Wiikite*	Colum.	G.=3.8–4.8. Insol.	167
?	Tet.	Red-br.	2.05	*Risoerite*	Tant.	G.=4.18. Sol. H_2SO_4	165
None	Orth.	Red-br.	2.06–2.26	*Euxenite*	Tit.	G.=4.8. Insol.	167
010 poor	Orth.	Brown	2.10–2.25	*Samarskite*	Colum.	G.=5.7±. Insol.	166
111 poor	Tet.	Brown	2.10–2.19	*Fergusonite*	Colum.	G.=5.8. Dec. H_2SO_4	164
None	Orth.	Br.-red	2.13	*Ampangabéite*	Colum.	G.=4.0–4.3. Sol. HCl	166
010 poor	Orth.	Brown	2.14	*Blomstrandinite*	Tit.	G.=4.9±. Insol.	167
010 poor	Orth.	Red-br.	2 15	*Yttrotantalite*	Tant.	G.=5.5–5.9. Insol.	166
?	Orth.	Red-br.	2.20–2.26	*Eschynite*	Colum.	G.=4.9–5.1. Insol.	167
100, 010	Orth.	Red-br.	2 215	*Polymignite*	Tit.	G.=4.8. Insol.	167
?	Tet.	Gr., br.	2.30	*Brannerite*	Ox.	G.=4.5–5.4. Sol. HCl	69

D. Brown in thin section and isometric

None	Dodec.	Red, br.	1.86–2.01	Schorlomite	Sil.	G.=3.7–3.9. Insol.	183
111 poor	Oct.	Brown	2.05	Picotite	Ox.	G.=4.1±. Sol. H_2SO_4	62
None	Oct.	Br., red	2.07–2.16	**Chromite**	Ox.	G.=4.5. Insol.	62
None	Oct.	Red-br.	2.19	*Zirkelite*	Ox.	G.=4.72. Insol.	164
?	Cub.	Red-br.	2.20	*Thorianite*	Ox.	G.=9.3. Sol. HNO_3	50
100 poor	Cub.	Brown	2.30	*Knopite*	Tit.	G.=4.1–4.3. Dec. H_2SO_4	163
100	Cub.	Brown	2.33	*Dysanalite*	Tit.	G.=4.13. Dec. HCl	163
110 perf.	Tet'h.	Brown	2.37–2.47	Sphalerite	ZnS	G.=4±. Sol. HCl	19
100 poor	Cub.	Br., red	2.38	Perovskite	Tit.	G.=4. Dec. H_2SO_4	163

E. Red in thin section and not isometric

?	Tet.	Red-br.	2.05	*Risoerite*	Tant.	G.=4.18. Sol. H_2SO_4	165
None	Orth.	Red-br.	2.06–2.26	*Euxenite*	Tit.	G.=4.8. Insol.	167
None	Orth.	Br.-red	2.13	*Ampangabéite*	Colum.	G.=4.0–4.3. Sol. HCl	166

TABLE II.—BIREFRINGENCE OF MINERALS

O. BIREFRINGENCE ZERO: $N_g - N_p = 0.000$—*continued*

Cleavage, Optic Orient.	Habit, etc.	Color	N	Mineral	Chem.	Other Characters	Page
				E. Red in thin section and not isometric—*continued*			
010 poor	Orth.	Red-br.	2.15	*Yttrotantalite*	Tant.	G.=5.5-5.9. Insol.	166
100, 010	Orth.	Red-br.	2.20-2.26	*Eschynite*	Colum.	G.=4.9-5.1. Insol.	167
None	Mass.	Red	2.2-2.3	**Limonite**	Ox.	G.=4±. Sol. HCl	47
				F. Red in thin section and isometric			
None	Dodec.	Red, br.	1.86-2.01	Schorlomite	Sil.	G.=3.7-3.9. Insol.	183
None	Oct.	Br., red	2.07-2.16	**Chromite**	Ox.	G.=4.5. Insol.	62
?	Dodec.	Red	2.12-2.18	*Koppite*	Tant.	G.=4.5. Dec. H_2SO_4	164
?	Oct.	Red	2.16	*Pyrrhite*	Tant.	G.=4.5. Dec. H_2SO_4	164
None	Oct.	Red-br.	2.19	*Zirkelite*	Ox.	G.=4.72. Insol.	164
?	Cub.	Red-br.	2.20	*Thorianite*	Ox.	G.=9.3. Sol. HNO_3	50
100 poor	Cub.	Br., red	2.38	Perovskite	Tit.	G.=4. Dec. H_2SO_4	163
111 perf.	Isom.	Tinted±	2.42	Diamond	C	G.=3.5. H.=10. Insol.	13
100 poor	Oct.	Red	2.69	*Hauerite*	MnS_2	G.=3.46. Sol. HCl	24
None	Tet'h.	Red	2.72+	Tetrahedrite	Cu, Sb, S	G.=4.4-5.1. Dec. HNO_3	26
111 poor	Oct.	Red	2.85	Cuprite	Cu_2O	G.=6±. Sol. H_2SO_4	40
				G. Blue or green in thin section			
100	Cub.	Blue	2.05	*Percylite*	Hal.	G.=2.25. Sol. HNO_3	37
100	Oct.	Green	2.16	*Manganosite*	MnO	G.=5.18. Sol. HCl	41
?	Oct.	Green	2.23	*Bunsenite*	NiO	G.=6.4 Sol. HCl	41
?	Tet.	Gr., br.	2.30	*Brannerite*	Ox.	G.=4.5-5.4. Sol. HCl	69
111 perf.	Isom.	Tinted±	2.42	Diamond	C	G.=3.5. H.=10. Insol.	13
100 perf.	Tet'h.	Green	2.70	*Alabandite*	MnS	G.=4.0. Sol. HCl	20

I. Birefringence very weak: $N_g - N_p < 0.0035$

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 8. Refringence negative and distinct: N_o or $N_m < 1.48$. Optically + or −							
100	?	0°	Tet.	*Villiaumite*	NaF	X=yellow; Z=red. Sign −	30
$10\bar{1}0$ dist.	Prism.	0°	Hex.	*Yttrocalcite*	Hal.	G.=3.2. Sol. HCl. Sign −	36
111 dist.	Oct.	0°	?	*Faujasite* ($-H_2O$)	Sil.	Also isotropic. Sign +	382
X=*c*	Prism.	Sm.	Orth.	*Malladrite*	Hal.	G.=2.75. Sign −	37
Y⊥100 cl.	Prism.	57°	Orth.	*Piilolite*	Sil.	X=*c*. G.=2.1. Insol. HCl. Sign −	389
Z=*a*	Fib.	Lg.	Orth.	*Variscite* ($-H_2O$)	Phos.	*a*=lavender; *c*=violet	140
X=*c*. Y=*b*	001	Lg.	Orth.	*Avogadrite*	Hal.	G.=2.6. Sign −	34
001, 100	Ps. Rh.	Sm.	Mon.	Gmelinite	Sil.	G.=2.1. Dec. HCl. Sign ∓	385
001, 110	Ps. Is.	43°	Mon.	*Cryolite*	Hal.	X=*b*. Z∧*c*=−44°. Sign +	34
Group 9a. Refringence negative and low: N_o or $N_m > 1.48 < 1.54$. Optically +							
111 dist.	Oct.	0°	?	*Faujasite* ($-H_2O$)	Sil.	Also isotropic	382
Z⊥001 cl.	Prism.	0°	Tet.	Apophyllite	Sil.	Abn. int. colors. G.=2.35±	262
$10\bar{1}0$ perf.	Prism.	0°	Hex.	***Davyne***	Sil.	K-cancrinite	301
110 poor	Trap.	Sm.	?	**Leucite**	Sil.	Also isotr. Alters easily	291
$10\bar{1}1$ dist.	Ps. Rh.	Sm.	Mon.	Chabazite	Sil.	G.=2.1. Dec. HCl	384
100, 010	El. ∥ *c*	70°±	Mon.	Phillipsite	Sil.	Ps. Tet. twin. G.=2.2	393
Y∧*c*=3°±	Fib.	80°	Tr.	*Mesolite*	Sil.	Comp. twin. G.=2.27	399
Z∧*c*=20°	Fib.	Sm.	Tr.	*Pseudomesolite*	Sil.	Prism. cleav.	399
Group 9b. Refringence negative and low: N_o or $N_m > 1.48 < 1.54$. Optically −							
X⊥011 cl.	Prism.	0°	Tet.	Apophyllite	Sil.	Abn. int. colors. G.=2.35±	262
X=*c*	Pyr.	0°	Tet.	*Cristobalite*	SiO_2	G.=2.27. Sol. HF	53
X=*c*	Prism.	0°	Hex.	**NEPHELITE**	Sil.	G.=2.6. Gel. HCl	298
$10\bar{1}0$ perf.	Prism.	0°	Hex.	***Davyne***	Sil.	K-cancrinite	301

TABLE II.—BIREFRINGENCE OF MINERALS

I. Birefringence very weak: $N_g - N_p < 0.0035$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
				Group 9b. Refringence negative and low: N_o or $N_m > 1.48 < 1.54$. Optically—, *continued*			
$X = c$	Prism.	0°±	Hex.	*Milarite*	Sil.	G. = 2.57. Insol.	429
001 diff.	Ps. Is.	Sm.	?	**Analcite**	Sil.	Comp. twin. Isotr. at 130° C.	293
100	Ps. Is.	Sm.	?	*Chlorocalcite*	Hal.	Comp. twin. Hygrosc.	33
$Z \perp 010$ cl.	Prism.	60°±	Orth.	**Cordierite**	Sil.	Ps. Hex. twin. $X = c$. Colorless or **X = yel., Y = blue, Z = blue**	307
$10\bar{1}1$ dist.	Ps. Rh.	Sm.	Mon.	Chabazite	Sil.	G. = 2.1. Dec. HCl	384
$X \wedge c = 43°$	Var.	71°	Mon.	*Bloedite*	Sul.	G. = 2.23. Sol. H_2O	112
				Group 10a. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically +			
$Z \perp 001$ cl.	Prism.	0°	Tet.	Apophyllite	Sil.	Abn. int. colors. G. = 2.35±	262
$10\bar{1}0$ dist.	Rhom.	0°	Rhom.	*Rinneite*	Hal.	Abn. int. colors. G. = 2.35	33
$Z = c$	?	0°	Rhom.	*Chlormankalite*	Hal.	Yellow. Deliques.	33
$Z \perp 001$ cl.	001	Sm.	Mon.	**Penninite**	Sil.	Green. Ultra blue int. colors	281
				Group 10b. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically −			
$X \perp 001$ cl.	Prism.	0°	Tet.	Apophyllite	Sil.	Abn. int. colors. G. = 2.35±	262
$X = c$	Prism.	0°	Hex.	**NEPHELITE**	Sil.	G. = 2.6. Gel. HCl	298
$X = c$	Prism.	0°±	Hex.	*Milarite*	Sil.	G. = 2.57. Insol.	429
$Z \perp 010$ cl.	Prism.	60°±	Orth.	**Cordierite**	Sil.	Ps. Hex. twin. $X = c$. Colorless or **X = yel., Y = blue, Z = blue**	307
$X \perp 001$ cl.	001	Sm.	Mon.	**Penninite**	Sil.	Green. Ultra blue int. colors	281
$X \perp 001$ cl.	001	Sm.	Mon.	Delessite	Sil.	Green or pink. Str. disp.	282
$X \perp 001$ cl.	001	Sm.	Mon.	*Kaemmererite*	Sil.	Purple: $X < Y = Z$. G. = 2.8±	286
				Group 11a. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +			
$Z \perp 001$ cl.	001	0°±	Tet.	*Metatorbernite*	Phos.	Abn. int. colors	145

Z=*c*	?	0°	Rhom.	*Chlormankalite*	Hal.	Yellow. Deliques. G.=2.3	33
Z⊥0001 cl.	Var.	0°	Rhom.	Eudialite	Sil.	Colorless or X=yel., Z=red	417
Z⊥001 cl.	001	Sm.	Mon.	Ripidolite	Sil.	Green. Abn. int. colors	284
		Group 11b. Refringence positive and moderate: N_o or $N_m>1.59<1.66$. Optically −					
X=*c*	Prism.	0°	Hex.	**Apatite**	Phos.	Colorless or tinted	129
10$\bar{1}$0 dist.	?	0°	Hex.	*Merrillite*	Phos.	Also biax.? Sol. HNO_3	149
X⊥0001 cl.	?	0°	Hex.	*Gillespite*	Sil.	G.=3.33. Sol. HCl	401
X⊥0001 cl.	Var.	0°	Rhom.	*Eucolite*	Sil.	Colorless or X=red, Z=yel.	417
X⊥001 cl.	001	Sm.	Mon.	Diabantite	Sil.	Green. Abn. int. colors	283
X⊥001 cl.	001	Sm.	Mon.	Aphrosiderite	Sil.	Green. Abn. int. colors	284
X⊥001 cl.	001	Sm.	Mon.	Daphnite	Sil.	Green. Abn. int. colors	285
X⊥001 cl.	001	Sm.	Mon.	*Kaemmererite*	Sil.	Purple: X<Y=Z. G.=2.8±	286
		Group 12. Refringence positive and high: N_o or $N_m>1.66<1.74$. Optically + or −					
Z=*c*	Prism.	0°	Tet.	*Viluite*	Sil.	Tinted ±. Sign +	207
X=*c*	Prism.	0°	Tet.	Vesuvianite	Sil.	Tinted ±. Sign −	207
X=*c*	Prism.	0°	Hex.	**Chlorapatite**	Phos.	G.=3.2. Sign −	129
Z∧*c*=10°±	010	69°	Mon.	***Sapphirine***	Sil.	Blue; pleo. Sign −	427
001, 010?	Fib.	?	Mon.	*Sarcopsite*	Phos.	Yellow. G.=3.64. Sign?	134
		Group 13. Refringence positive and high: N_o or $N_m>1.74<2.00$. Optically + or −					
X⊥0001 cl.	Prism.	0°	Hex.	*Swedenborgite*	Antim.	G.=4.3. Insol. Sign−	149
No cleav.	Prism.	25°	Orth.	*Cerite*	Sil.	Colorless or Z=red. Sign +	422
Two at 90°	?	Sm.	Orth.	*Hyalotekite*	Sil.	G.=3.8. Sol. HF. Sign +	422
?	Fib.	Lg.	Mon.	*Agricolite*	Sil.	G.=6. Gel. HCl. Sign +?	414
		Group 14. Refringence positive and extreme: N_o or $N_m>2.00$. Optically + or −					
110 poor	Ps. Is.	0°	?	*Eulytite*	Sil.	G.=6.1. Gel. HCl. Sign −	414
X=*c*. Y=*b*	Ps. Is.	90°±	Orth.	Perovskite	Tit.	Gray or brown. Sign +	163
?	Fib.	Lg.	Mon.	*Agricolite*	Sil.	G.=6. Gel. HCl. Sign +?	414

TABLE II. BIREFRINGENCE OF MINERALS

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II. BIREFRINGENCE WEAK: $N_g - N_p > 0.0035 < 0.0095$

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
				Group 15a. Refringence negative and distinct: N_o or $N_m < 1.48$. Optically +			
				A. No visible cleavage			
$Z \perp 0001$ pt.	0001	0°	Hex.	**Ice**	H_2O	Skel. cryst. are "snow"	40
$Z \perp 001$ pt.	001	35°	Orth.	Tridymite	SiO_2	Ps. Hex. twin. G. = 2.27	58
$X = c =$ elong.	Fib.	Sm.	Orth.	*Paraluminite*	Sul.	G. = 1.66. Sol. HCl	109
$Z \wedge c = 28° \pm$	Fib.	Mod.	Mon.	*Pickeringite*	Sul.	$Y = b$. G = 1.85. Sol. H_2O	116
$10\bar{1}0$ dist.	Ps. Rh.	Sm.	Mon.	Gmelinite	Sil.	Comp. twin. G. = 2.75	385
$Z \wedge 001$ cl. = 22°	Prism.	76°	Mon.	*Pachnolite*	Hal.	100 twin. G. = 3.0	36
				B. One or more visible cleavages			
$X \perp 100$ cl.	El. ‖ c	50°	Orth.	*Ferrierite*	Sil.	$Z = c$. G. = 2.15	389
$X \perp 010$ cl.	c or 010	Lg.	Mon.	*Mordenite*	Sil.	$Z \wedge c = -73°$. G. = 2.1	398
$X \wedge \bar{2}01$ cl. = 37°	Prism.	50°	Mon.	*Boussingaultite*	Sul.	$Y = b$. G. = 1.72	113
$X \perp 010$ cl.	c or 010	69°	Mon.	*Alunogen*	Sul.	$Z \wedge c = 42°$. G. = 1.65	109
				Group 15b. Refringence negative and distinct: N_o or $N_m < 1.48$. Optically −			
$X \perp 001$ cl.	Pyr.	0°	Tet.	*Chiolite*	Hal.	G. = 3. Very rare	34
$10\bar{1}0$ perf.	Acic.	0°	Hex.	*Ettringite*	Sul.	G. = 1.8. Sol. HCl	115
$10\bar{1}0$ dist.	Ps. Rh.	Sm.	Mon.	Gmelinite	Sil.	Comp. twin. G. = 2.75	385
$X \wedge 001$ cl. = 41°	Ps. Is.	50°	Mon.	*Thomsenolite*	Hal.	$Z = b$. G. = 3.0	36
$Y \wedge c =$ Lg.	Acic.	Mod.	Mon.	*Gearksutite*	Hal.	Chalky. G. = 2.75	35
$Z \wedge 100$ cl. = 29°	Prism.	76°	Mon.	Mirabilite	Sul.	$Y = b$. G. = 1.46. Sol. H_2O	97

Group 16a. Refringence negative and low: N_o or $N_m > 1.48 < 1.54$. Optically +

A. No visible cleavage

$10\bar{1}0$ dist.	Acic.	0°	Hex.	*Leifite*	Sil.	G. = 2.27. Sol. HCl	429
$10\bar{1}0$ dist.	0001	0°	Rhom.	*Aphthitalite*	Sul.	G. = 2.7. Sol. H_2O	96
$10\bar{1}1$ dist.	Ps. Rh.	Sm.	Mon.	Chabazite	Sil.	0001 twin. G. = 2.1	384
$X \wedge c = 4°$	010	39°	Mon.	*Wellsite*	Sil.	$Y = b$. G. = 2.3	395
$Y \perp 010$ cl.	El. ‖ c	43°	Mon.	***Harmotome***	Sil.	$X \wedge c = 62°$. G. = 2.5	395
$Z \wedge c = 20°$	El. ‖ c	70°	Mon.	Phillipsite	Sil.	$Y = b$. G. = 2.0	393
$Z \wedge c = 50°$	010	63°	Mon.	*Prosopite*	Hal.	$Y = b$. G. = 2.9	34
$Y \wedge$ fib. = Lg.	Fib.	Lg.	Mon.	*Zn-Cu-Melanterite*	Sul.	$Z = b$. G. = 2	106

B. One or more visible cleavages

$10\bar{1}0$ perf.	Prism.	0°	Hex.	*Microsommite*	Sil.	G. = 2.45. Gel. HCl	301
$X \perp 001$ cl.	Prism.	37°	Orth.	*Struvite*	Phos.	$Z \perp 010$ cl. 001 twin.	151
$Z \perp 010$ cl.	Prism.	54° ±	Orth.	Thomsonite	Sil.	$Y = c$. G. = 2.3	387
$X \perp$ cleav.	Fib.	52°	Orth.	*Gonnardite*	Sil.	$Z = c$. G. = 2.25	387
$Z \perp 010$ cl.	010	34° ±	Mon.	Heulandite	Sil.	$Y \wedge c = 6°$. G. = 2.2	397
$Y \perp 010$ cl.	c or 010	58°	Mon.	Gypsum	Sul.	$Z \wedge c = 52°$. G. = 2.94	104
Z ‖ elong.	Lath.	Lg.	Tr.?	*Chalcoalumite*	Sul.	Bl.-green. Abn. int. colors	117
001, 010	a or 010	Lg.	Tr.	**PLAGIOCLASE**	Sil.	Lam. twin. G. = 2.6 ±	368

Group 16b. Refringence negative and low: N_o or $N_m > 1.48 < 1.54$. Optically −

A. No visible cleavage and no marked elongation

$X = c$	Prism.	0°	Hex.	*β-Kaliophilite*	Sil.	G. = 2.56. Gel. HCl	300
$X = c$	Prism.	0°	Hex.	**NEPHELITE**	Sil.	G. = 2.6. Gel. HCl	298
$X = c$	Rhom.	0°	Rhom.	*Levynite*	Sil.	G. = 2.1. Gel. HCl	386
$10\bar{1}1$ dist.	?	0°	Rhom.	*Tachyhydrite*	Hal.	Deliques.	32
$X = c$	?	39°	Orth.	*α-Kaliophilite*	Sil.	G. = 2.6. Gel. HCl	300
$Z \perp 010$ cl.	Prism.	60° ±	Orth.	Cordierite	Sil.	Ps. Hex. twin. $X = c$. Colorless or X = yel., Y = blue, Z = blue	307

TABLE II.—BIREFRINGENCE OF MINERALS

II. Birefringence weak: $N_g - N_p > 0.0035 < 0.0095$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
		Group 16b. Refringence negative and low: N_o or $N_m > 1.48 < 1.54$. Optically −, *continued*					
		A. No visible cleavage and no marked elongation—*continued*					
$10\bar{1}1$ dist.	Ps. Rh.	Sm.	Mon.	Chabazite	Sil.	0001 twin. G.=2.1	384
$X=b$. $Z=a\pm$	Ps. Tet.	83°	Mon.	*Gismondite*	Sil.	G.=2.27. Gel. HCl	373
$Z \wedge c$=Sm.	Tab.	86°	Mon.	*Leonite*	Sul.	$Y=b$. G.=2.25. Sol. H_2O	112
No cleav.	?	84°	Mon.	*Vanthoffite*	Sul.	G.=2.7. Sol. H_2O	111
?	Prism.	13°±	Tr.	*Carnegieite*	Sil.	G.=2.5. Gel. HCl	299
		B. No visible cleavage and marked elongation					
100 dist.	El. ∥ c	0°	Tet.	Marialite	Sil.	G.=2.57. Also +?	296
$X=c$?	Fib.	0°?	Hex.?	Chalcedonite	SiO_2	G.=2.6. Sol. HF	57
$Z=c$	Fib.	25°±	Orth.	Sepiolite	Sil.	G.=2.0	410
$Z \wedge c=37°$	Fib.	Mod.	Mon.	*Pickeringite*	Sul.	$Y=b$. G.=1.85	116
$Z \wedge c=29°$	Fib.	Sm.	Mon.	*Apjohnite*	Sul.	$Y=b$. G.=1.8	117
$X \wedge c=43°$	Prism.	71°	Mon.	*Bloedite*	Sul.	Also 001 tab. G.=2.2	112
$Z \wedge c=30°$	Fib.	?	Mon.	*Halotrichite*	Sul.	G.=1.9. Sol. H_2O	116
		C. One or more visible cleavages					
$10\bar{1}0$ perf.	Prism.	0°	Hex.	Cancrinite	Sil.	G.=2.45. Gel. HCl	301
$10\bar{1}0$ perf.	Prism.	0°	Hex.	*Natrodavyne*	Sil.	G.=2.45. Gel. HCl	301
$Y \perp 010$ cl.	010	33°	Mon.	Stilbite	Sil.	$X \wedge c=5°$. G.=2.15	395
110 perf.	Prism.	36°	Mon.	Scolecite	Sil.	$X \wedge c=16°$. $Z=b$. G.=2.3	390
100 perf.	?	Lg.	Mon.	*Searlesite*	Sil.	$Z=b$. $X \wedge c=30°$	423
001, 010	Prism.	70°	Mon.	**ADULARIA**	Sil.	$X \wedge a=6°$. $Z=b$. G.=2.56	361

001, 010	010	Sm.	Mon.	**SANIDINE**	Sil.	$X\wedge a=6°$. $Y=b$. G.=2.57	361
001, 010	Prism.	76°±	Mon.	**Hyalophane**	Sil.	$X\wedge a=0°–20°$. $Z=b$	360
001, 010	Prism.	83°±	Tr.	**MICROCLINE**	Sil.	Two sets lam. twin.	364
001, 010	Prism.	45°±	Tr.	**ANORTHOCLASE**	Sil.	Lam. twin. Also 010 tab.	366
001, 010	*a* or 010	85°±	Tr.	**OLIGOCLASE**	Sil.	Lam. twin. Also prism.	371

Group 17a. Refringence positive and low: N_o or $N_m>1.53<1.59$. Optically +

A. No visible cleavage

$Z=c$	Prism.	0°	Hex.	**QUARTZ**	SiO_2	G.=2.65. Sol. HF	54
$10\bar{1}0$ poor	Prism.	0°	Rhom.	*Coquimbite*	Sul.	Abn. int. colors. G.=2.1	107
Z ∥ fib.	Fib.	0°	?	*Cerulcolactite*	Phos.	Colorless or blue	143
Z ∥ fib.	Fib.	Sm.	Orth.	*Nouméite*	Sil.	Green. Dec. HCl	261
$Z\wedge$fib.=31°	Fib.	?	Mon.	*Jurupaite*	Sil.	G.=2.75. Sol. HCl	412
Z⊥010 cl.	El. ∥ *c*	47°	Mon.	*Bazenite*	Sil.	$X\wedge a=2°$. 100 twin.	438

B. One or more visible cleavages

Z⊥010 cl.	Prism.	54°±	Or.	Thomsonite	Sil.	Y ∥ elong. G.=2.3	387
Z⊥001 cl.	001	Sm.	Mon.	**Clinochlore**	Sil.	Green; weak pleo. G.=2.7±	283
Z⊥001 cl.	001	Sm.	Mon.	Prochlorite	Sil.	Green; weak pleo. G.=2.8+	284
$Z\wedge$001 cl.=28°	001	30°	Mon.	*Eudidymite*	Sil.	001 twin. G.=2.55	418
001, 010	*a* or 010	82°±	Tr.	**ANDESINE**	Sil.	Lam. twin.	372
001, 010	*a* or 010	82°±	Tr.	**LABRADORITE**	Sil.	Lam. twin	374

Group 17b. Refringence positive and low: N_o or $N_m>1.53<1.59$. Optically −

B. No visible cleavage

110 dist.	El. ∥ *c*	0°	Tet.	Marialite	Sil.	G.=2.57. Also+?	296
0001 dist.	Prism.	0°	Hex.	*Eucryptite*	Sil.	G.=2.67. Gel. HCl	300
$X=c$?	Fib.	0°	Hex.?	Chalcedonite	SiO_2	G.=2.6. Sol. HF	57
$X=c$	Prism.	0°	Hex.	*β-Kaliophilite*	Sil.	G.=2.55. Gel. HCl	300
$X=c$	Prism.	0°	Hex.	**NEPHELITE**	Sil.	G.=2.6. Gel. HCl	298

TABLE II.—BIREFRINGENCE OF MINERALS

II. Birefringence weak: $N_g - N_p > 0.0035 < 0.0095$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 17b. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically −, *continued*							
B. No visible cleavage—*continued*							
$X=c$	Prism.	0°	Hex.	Beryl	Sil.	Colorless; blue, green; pleo.	212
?	?	39°	Orth.	*α-Kaliophilite*	Sil.	Ps. Hex. twin. G.=2.5±	300
$Z \perp 010$ cl.	Prism.	60°±	Orth.	**Cordierite**	Sil.	Ps. Hex. twin. $X=c$. Colorless or X=yel., Y=blue, Z=blue	307
$X=b$. $Z=a\pm$	Ps. Tet.	83°	Mon.	*Gismondite*	Sil.	G.=2.27. Gel. HCl	373
$Z \wedge c=12°$	Fib.	Lg.	Mon.	***Crestmorite***	Sil.	G.=2.2. Dec. HCl	409
B. One visible cleavage (lamellar)							
001 perf.	001	0°	Tet.	*Metazeunerite*	Arsen.	Green: X<Z. G.=3. Sol. HNO_3	146
0001 perf.	0001	0°	Rhom.	*Reyerite*	Sil.	G.=2.52. Sol. HCl	408
$X \perp 0001$ cl.	0001	0°±	Rhom.	*Zeophyllite*	Sil.	G.=2.76. Also biax.	408
$X \perp 001$ cl.	Ps. Hex.	0°±	Mon.?	*Calcioferrite*	Phos.	G.=2.53. Dec. HCl	156
001 perf.	001	60°	Mon.	**Kaolinite**	Sil.	$Y \wedge a=11°$. $Z=b$. G.=2.6	264
$X \perp 001$ cl.±	001	?	Mon.	*Faratsihite*	Sil.	Sol. HCl	416
$X \perp 001$ cl.±	001	90°±	Mon.	*Miloschite*	Sil.	Bl.-green. G.=2.1	416
$X \perp 001$ cl.±	001	40°±	Mon.	**Antigorite**	Sil.	Green; weak pleo. G.=2.57	280
$X \perp 001$ cl.±	001	Sm.	Mon.	*Jenkinsite*	Sil.	Green; weak pleo. Sol. HCl	281
C. Two visible cleavages							
100, 010	Prism.	0°±	Orth.	*β-Hopeite*	Phos.	$X=b$. G.=3.0	124
001, 010	001	23°	Orth.	*Epididymite*	Sil.	$X=b$. $Y=c$. G.=3.55	418
001, 010	Prism.	75°±	Mon.	**Hyalophane**	Sil.	$X \wedge a=0°–25°$. $Z=b$.	360

001, 010	*a* or 010	85°±	Tr.	**OLIGOCLASE**	Sil.	Lam. twin.	371
001, 010	*a* or 010	82°±	Tr.	**ANDESINE**	Sil.	Lam. twin.	372
001, 010	*a* or 010	85°±	Tr.	**BYTOWNITE**	Sil.	Lam. twin.	376

Group 18a. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +

A. No visible cleavage

001, 110	001	0°	Tet.	**Akermanite**	Sil.	G.=3.18. Gel. HCl	209
Z=*c*	?	0°	Rhom.	*Gorceixite*	Phos.	G.=3.1	153
0001 dist.	Var.	0°	Rhom.	*Eudialite*	Sil.	Colorless or yel. to red	417
Z ‖ fib.	Fib.	Sm.	Orth.	*Nouméite*	Sil.	Gr.; weak pleo. G.=2.5±	261
Z ‖ fib.	Fib.	Sm.	Orth.	*Foshagite*	Sil.	G.=2.36. Gel. HCl	408
Z=*c*	Ps. Tet.	0°±	Orth.	*Uranochalcite*	Sul.	X, Y=green, Z=gr.-yellow	117

B. One or more visible cleavages

0001 perf.	0001	0°	Rhom.	*Goyazite*	Phos.	Colorless or yellow	153
Z⊥001 cl.	Prism.	60°+	Orth.	Topaz	Sil.	Y=*b*. G.=3.55±	198
001, 110	001	51°	Orth.	Celestite	Sul.	Y=*b*. Z=*a*. G.=4.0	99
110 at 88°	Prism.	70°±	Orth.	**ENSTATITE**	Sil.	Y=*b*. Z=*c*. G.=3.2	217
110 at 88°	Prism.	53°	Mon.	**CLINOENSTATITE**	Sil.	Y=*b*. $Z \wedge c = +22°$	220
Z⊥001 cl.±	001	Sm.	Mon.	Prochlorite	Sil.	Y=*b*. Green; weak pleo.	284
010, 100	El. ‖ *c*	40°	Mon.	*Picropharmacolite*	Arsen.	$X \wedge c = 37°$. Y=*b*	125

Group 18b. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically −

A. No visible cleavage and no marked elongation

X=*c*	Prism.	0°	Hex.	**Apatite**	Phos.	Colorless or tinted	129
X=*c*	Prism.	0°	Hex.	***Wilkeite***	Phos.	G.=3.2. Sol. HCl	440
0001 poor	Prism.	0°	Hex.	Beryl	Sil.	G.=2.6–2.9. Sol. HF	212
0001 dist.	Var.	0°	Rhom.	***Eucolite***	Sil.	Colorless or yel. to red	417
X ‖ 110 cl.	Prism.	84°	Orth.	**Andalusite**	Sil.	Y=*b*. Colorless or yel. to red	201

TABLE II.—BIREFRINGENCE OF MINERALS

II. BIREFRINGENCE WEAK: $N_g - N_p > 0.0035 < 0.0095$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 18b. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically −, *continued*							
A. No visible cleavage and no marked elongation—*continued*							
$X=b$. $Y=c$	Prism.	89°	Orth.	Danburite	Sil.	G.=3.0. Sol. HF	210
$X \wedge c = 35° \pm$	El. ‖ *b*	Lg.	Mon.	**Allanite**	Sil.	$Y=b$. X=yellow, Z=brown	316
?	?	Lg.	Mon.	*Palaite*	Phos.	G.=3.2. Sol. HCl	124
B. No visible cleavage and marked elongation							
$X=c$	c or 0001	0°	Hex.	*Francolite*	Phos.	G.=3.1. Sol. HCl	161
Z ‖ fib.	Fib.	0°	Hex.	*Dahllite*	Phos.	Also biax. G.=3.	161
Z ‖ 110 cl.	Prism.	70°?	Orth.	*Hillebrandite*	Sil.	$Y=b$. G.=2.7. Sol. HCl	408
$Z \wedge 100$ cl.=12°	El. ‖ *c*	Lg.	Mon.	*Crestmorite*	Sil.	G.=2.22. Dec. HCl	409
C. One or more visible cleavages							
0001 perf.	Var.	0°	Hex.	*Fluocerite*	Hal.	G.=5.7–6.1. Sol. H_2SO_4	33
110 at 56°	Prism.	Sm.	Mon.	*Crossite*	Sil.	$X \wedge c = 70° \pm$. $Z=b$. X=yellow, Z=violet	259
X ⊥ 001 cl.	001	Sm.	Mon.	Thuringite	Sil.	X=colorless; Y, Z=green	285
X ⊥ 001 cl.	001	Sm.	Mon.	*Jenkinsite*	Sil.	Olive green	281
Group 19a. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +							
A. No visible cleavage							
0001 dist.	Rhom.	0°	Rhom.	*Florencite*	Phos.	G.=3.6. Brownish in mass	142
$X=c$. $Y=b$	Prism.	52°	Orth.	*Harstigite*	Sil.	G.=3	432
X ⊥ 100 cl.	100	Lg.	Orth.	*Dewindtite*	Phos.	$Y=c$. Yellow. G.=4	148
001 dist.	Ps. Rh.	Sm.	Mon.	*Fillowite*	Phos.	Yellow. G.=3.4	123
No cleav.	?	90°±	Tr.?	*Serendibite*	Sil.	Lam. twin. Blue; pleo.	425

B. One or more visible cleavages

010 perf.	Prism.	30°±	Orth.	**Zoisite**	Sil.	Y=*b* (or *c*). Z=*a*. G.=3.3	311
Z ‖ 110 cl.	Prism.	70°±	Orth.	**ENSTATITE**	Sil.	Y=*b*. G.=3.2	217
001, 010	Prism.	Var.	Orth.	*Triphylite*	Phos.	X=*c*. Y=*a*. G.=3.5	149
Z∧001 cl.=20°	El. ‖ *b*	85°±	Mon.	**Clinozoisite**	Sil.	Y=*b*. G.=3.36	312
110 at 88°	Prism.	53°	Mon.	**Clinoenstatite**	Sil.	Z∧*c*=+22°. Y=*b*	220
Z∧100 cl.=4°	Prism.	Mod.	Mon.	*Triploidite*	Phos.	X=*b*. G.=3.7. Sol. HCl	134
Z⊥001 cl.±	001	50°±	Tr.	Chloritoid	Sil.	X=green, Y=blue, Z=yellow	438

Group 19b. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically −

A. No visible cleavage

X=*c*	Prism.	0°	Tet.	Vesuvianite	Sil.	Colorless or tinted. G.=3.4	207
X=*c*	Prism.	0°	Tet.	**Gehlenite**	Sil.	G.=3.0. Gel. HCl	209
0001 poor	Prism.	0°	Hex.	*Svabite*	Arsen.	G.=3.5. Sol. HCl	129
Y=*b*	Ps. Is.	Sm.	Mon.	*Pharmacosiderite*	Phos.	G.=3.0. Sol. HCl	143
Z∧*c*=10°	010	69°	Mon.	*Sapphirine*	Sil.	Y=*b*. X=yellow; Y, Z=blue	427
X∧*c*=35°±	El. ‖ *b*	Lg.	Mon.	**Allanite**	Sil.	Y=*b*. X=yellow; Z=brown	316

B. One or more visible cleavages

110 at 56°	Prism.	Lg.	Mon.	**Riebeckite**	Sil.	X∧*c*=Sm. Z=*b*. X, Y=blue; Z=green	257
110 at 56°	Prism.	Lg.	Mon.	Arfvedsonite	Sil.	Z=*b*. X=blue, Y=violet, Z=yellow	257
110 at 56°	Prism.	Sm.	Mon.	*Crossite*	Sil.	Z=*b*. X=yellow, Y=blue, Z=violet	259

Group 20a. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +

10$\bar{1}$1	Rhom.	0°	Rhom.	*Arsenioplcite*	Arsen.	Blood red. Sol. HCl	153
No cleav.	Prism.	25°	Orth.	*Cerite*	Sil.	Colorless or red: X<Z	422
X⊥100 cl.	100	Lg.	Orth.	*Dewindtite*	Phos.	Yellow. G.=4.1	148
Z∧*c*=+8°	Prism.	85°	Mon.	*Gadolinite*	Sil.	Y=*b*. G.=4.3±. Gel. HCl	424
110 at 66°	Prism.	32°	Tr.	Enigmatite	Sil.	Y=*b*. Z∧*c*=45°±. Brown; pleo.	428
Z⊥001 cl.±	001	50°±	Tr.	Chloritoid	Sil.	X=green, Y=blue, Z=yellow	438

TABLE II.—BIREFRINGENCE OF MINERALS

II. Birefringence weak: $N_g-N_p>0.0035<0.0095$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 20b. Refringence positive and very high: N_o or $N_m>1.74<2.00$. Optically −							
0001 part.	Var.	0°	Hex.	Corundum	Al_2O_3	Colorless or blue, red, etc.	43
0001 dist.	Rhom.	0°	Rhom.	*Beudantite*	Sul.	Also biax. G.=4.1	119
0001 dist.	Rhom.	0°	Rhom.	*Corkite*	Sul.	Also biax. G.=4.2	119
Group 21. Refringence positive and extreme: N_o or $N_m>2.00$. Optically + or −							
X ‖ fib.	Fib.	0°	Tet.	*Minium*	Pb_3O_4	X=red−br., Z=colorless. Sign ?	65
111 poor	Ps. Is.	Lg.	Orth.	*Senarmontite*	Sb_2O_3	Octahedral. Sign +	43
X=*a*. Z=*b*	Ps. Is.	90°±	Orth.	*Dysanalite*	Tit.	X=gray. Z=green. Sign +	163
?	Acic.	?	Orth.	*Cervantite*	Ox.	G.=4. Sol. HCl	67

III. Birefringence moderate: $N_g-N_p>0.0095<0.0185$

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 22a. Refringence negative and distinct: N_o or $N_m<1.48$. Optically +							
A. No visible cleavage							
Z ‖ elong.	Fib.	0°?	?	Chrysocolla	Sil.	Opt. data discordant	411
?	Conch.	36°	Orth.	*Taylorite*	Sul.	G.=2.5? Sol. H_2O	96
X ‖ fib.	Fib.	Lg.	Orth.	*Aluminite*	Sul.	G.=1.66. Sol. HCl	109
Z ‖ fib.	El. ‖ *c*	65°?	Orth.	*Erionite*	Sil.	G.=2.0. Sol. HCl	389
Y ⊥ 001 cl.	Var.	83°	Orth.	*Thenardite*	Sul.	G.=2.68. Sol. H_2O	96
Z ‖ 110 cl.	Fib.	0°±	Mon.	*Laubanite*	Sil.	G.=2.2. Gel. HCl	438
B. One or more visible cleavages							
100, 110	Prism.	0°	Tet.	*Sellaite*	MgF_2	G.=3.17. Sol. H_2SO_4	32
X ‖ 110 cl.	Prism.	62°±	Orth.	Natrolite	Sil.	Y=*b*. Ps. Tet. G.=2.55	390
$20\bar{1}$ perf.	Prism.	48°	Mon.	*Picromerite*	Sul.	$X\wedge c=14°$. Y=*b*. G.=2.1	112
X ⊥ 010 cl.	Fib.	69°	Mon.	*Alunogen*	Sul.	$Z\wedge c=42°$. G.=1.65. Sol. H_2O	109
001, 110	Fib.	86°	Mon.	*Melanterite*	Sul.	Y=*b*; $Z\wedge c=-62°$. G.=1.9	106

Group 22b. Refringence negative and distinct: N_o or $N_m < 1.48$. Optically −

Y ∥ 110 cl.	**Prism.**	40°	Orth.	*Lecontite*	Sul.	X = *a*. Sol. H_2O	97

Group 23a. Refringence negative and low: N_o or $N_m > 1.48 < 1.54$. Optically +

A. Extinction parallel with elongation or cleavage in chief zones

Z = *c*	?	0°	?	*Douglasite*	Hal.	Sol. H_2O	34
Z ∥ 110 cl.	Fib.	Sm.	Orth.	**Chrysotile**	Sil.	Colorless or yel. to green	260
Z ⊥ 001 cl.	001	48°	Orth.	*Felsöbányite*	Sul.	G. = 2.33. Sol. HCl	109
X ⊥ 010 cl.	El. ∥ *c*	50°	Orth.	*Echellite*	Sil.	Y = *c*. Dec. HCl	389
Z ⊥ 010 cl.	El. ∥ *c*	54°	Orth.	Thomsonite	Sil.	Y = *c*. G. = 2.3. Gel. HCl	382
X ∥ 110 cl.	El. ∥ *c*	62°	Orth.	Natrolite	Sil.	Y = *b*. Ps. Tet. G. = 2.55.	390
Z ⊥ 010 cl.	El. ∥ *c*	Mod.	Mon.	*Hydromagnesite*	Carb.	$Y \wedge c = -43°$. G. = 2.16	85

B. Extinction inclined to elongation or cleavage

Z ⊥ 010 cl.	El. ∥ *c*	Mod.	Mon.	*Hydromagnesite*	Carb.	$Y \wedge c = -43°$. G. = 2.16	85
Y ⊥ 010 cl.	Prism.	44°	Mon.	*Epistilbite*	Sil.	$Z \wedge c = -10°$. G. = 2.25	396
$Y \wedge c = 30°$	El. ∥ *c*	60°	Mon.	*Tamarugite*	Sul.	Z = *b*. G. = 2.3. Sol. H_2O	115
Z ⊥ 010 cl.	El. ∥ *c*	65°	Mon.	*Brewsterite*	Sil.	$X \wedge c = +22°\pm$. Dec. HCl	397
001 perf.	El. ∥ *a*	84°	Mon.	*Petalite*	Sil.	$X \wedge a = 5°$. Z = *b*. G. = 2.4	309
Lg. ext. ang.	Prism.	Lg.	Mon.	*Aluminite* (alt.)	Sul.	Dehydrated? G. = 1.77	109
$Z \wedge c = 29°$	El. ∥ *c*	Lg.	Mon.	*Dietrichite*	Sul.	X = *b*. Sol. H_2O	117
$Z \wedge c = 33°$	Fib.	Lg.	Mon.	*Misenite*	Sul.	G. = 2.24. Sol. H_2O	96
001, 010	*a* or 010	75° ±	Tr.	**ALBITE**	Sil.	$Y \wedge c = 7°\pm$. $Z \wedge 010 = 75°\pm$	369

Group 23b. Refringence negative and low: N_o or $N_m > 1.48 < 1.54$. Optically −

A. No visible cleavage

Z ⊥ 010 cl.	Prism.	60° ±	Orth.	**Cordierite**	Sil.	Ps. Hex. twin. X = *c*. Colorless or **X** = yel., **Y** = blue, **Z** = blue	307
110, 001	Prism.	70°	Orth.	*Sulfoborite*	Bor.	X = *c*. Y = *b*. G. = 2.4	120
Z = *c*	Fib.	Var.	Orth.	Sepiolite	Sil.	G. = 2.0. Sol. HF	410
No cleav.	Mass.	Lg.	?	*Racewinite*	Sil.	G. = 1.96 ±. Green to brown	433

TABLE II.—BIREFRINGENCE OF MINERALS

III. Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
				Group 23b. Refringence negative and low: N_o or $N_m > 1.48 < 1.54$. Optically −, *continued*			
				A. No visible cleavage—*continued*			
Y⊥010 cl.	?	80°±	Mon.	*Didymolite*	Sil.	$X \wedge c = 40°$. G. = 2.7	428
?	Prism.	Mod.	Tr.	*Siderotil*	Sul.	Bl.-green. G. = 2.2	107
?	?	Mod.	Tr.	*Co-chalcanthite*	Sul.	G. = 2.2 Sol. H_2O	107
				B. One or more visible cleavages			
0001 perf.	0001	0°	Hex.	*Hydrotalcite*	Carb.	G. = 2.06. Sol. HCl	87
10$\bar{1}$0 perf.	Acic.	0°	Hex.	*Ettringite*	Sul.	G. = 1.79. Sol. HCl	115
X⊥0001 cl.	0001	0°	Rhom.	*Gyrolite*	Sil.	G. = 2.4. Also biax.?	408
Y⊥010 cl.	El. ‖ *c*	44°	Orth.	*Stellerite*	Sil.	$X = c$. G. = 2.12	389
Y⊥100 cl.	Prism.	40°	Orth.	*Epidesmine*	Sil.	$X = c$. G. = 2.16	388
Y⊥010 cl.	El. ‖ *c*	33°	Mon.	Stilbite	Sil.	$X \wedge c = 5°$. G. = 2.2	395
Y⊥010 cl.	Prism.	25°	Mon.	Laumontite	Sil.	$Z \wedge c = -27°$. G. = 2.3	391
110, 100	Prism.	28°	Mon.	*Syngenite*	Sul.	$Y \wedge c = -3°$. $Z = b$. G. = 2.6	111
010 perf.	Fib.	Lg.	Tr.	*Okenite*	Sil.	$Z = c \pm$. G. = 2.3. Gel. HCl	413
				Group 24a. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically +			
				A. No visible cleavage and no marked elongation			
$Z = c$	Pyr.	0°	Tet.	*Soumansite*	Phos.	G. = 2.87. Also biax.	151
$Z = c$	Prism.	0°	Tet.	*Pinnoite*	Bor.	G. = 2.29. Sol. HCl	92
0001 dist.	0001	0°	Rhom.	*Natroalunite*	Sul.	G. = 2.6	114
?	?	0°?	Rhom.	*Loewigite*	Sul.	G. = 2.58 Sign ?	114
$X = b$. $Y = c$	?	Mod.	Orth.	*Grothine*	Sil.	G. = 3.1. Sol. H_2SO_4	432
$Z \wedge c = -22°$	?	26°	Mon.	*Wagnerite*	Phos.	$Y = b$. G. = 3.0	134
Z⊥010 cl.	010	32°	Tr.	*Vauxite*	Phos.	$X' \wedge c = -27°$. Blue: $X = Z < Y$	157

B. No visible cleavage, but marked elongation

Z || fib.	Fib.	Sm.	Orth.	**Chrysotile**	Sil.	Colorless or yel. to gr.	260
Z || fib.	Fib.	Sm.	Orth.	*Deweylite*	Sil.	Colorless or yel. to gr.	261
Z = *c*	Fib.	Mod.	Orth.	*Barrandite*	Phos.	G. = 2.6. Sol. HCl	140
X || 110 cl.	Fib.	75°	Orth.	*Elpidite*	Sil.	G. = 2.58	400

C. One visible cleavage

Z || fib.	Fib.	Sm.	Orth.	*Xonotlite*	Sil.	One cleav. || elong.	409
X⊥010 cl.	El. || *c*	50°	Orth.	*Echellite*	Sil.	Y = *c*. Dec. HCl	389
Z⊥010 cl.	El. || *c*	54°	Orth.	Thomsonite	Sil.	Y = c. G. = 2.3. Gel. HCl	387
Z⊥001 cl.±	Ps. Hex.	Sm.	Mon.	Amesite	Sil.	Y = *b*. G. = 2.8	285
Z⊥001 cl.±	Ps. Hex.	Sm.	Mon.	*Sheridanite*	Sil.	Y = *b*. G. = 2.7	283
Z⊥001 cl.±	Ps. Hex.	Sm.	Mon.	Corundophilite	Sil.	Y = *b*. G. = 2.9	283
Y⊥010 cl.	Acic.	50°	Mon.	*Isoclasite*	Phos.	Z∧*c* = Sm. G. = 2.9	137
001, 110	Gran.	60°	Mon.	*Custerite*	Sil.	X = *b*. Z∧*c* = 7°. G. = 2.9	412
010, 100	El. || *c*	Mod.	Mon.	*Hydromagnesite*	Carb.	Y∧*c* = −43°. Z = *b*. 100 twin.	85

D. Two or more visible cleavage directions

110 at 56°	Prism.	80°±	Orth.	**Anthophyllite**	Sil.	X = *a*. Z = *c*. Colorless or X, Y = brown Z = yellow or green	240
110, $\bar{1}$01	Var.	51°	Mon.	*Augelite*	Phos.	Y = *b*. Z∧*c* = −34°. G. = 2.7	143
Z⊥010 cl.	El. || *c*	Lg.	Mon.	*Brushite*	Phos.	301 cl. G. = 2.2.	123
110 at 56°	Fib.	Lg.	Mon.	*Kuppferite*	Sil.	Y = *b*. Z∧*c* = −11°. G. = 3.1	244
001, 010	**Prism.**	**Lg.**	Mon.	**Celsian**	Sil.	Y = *b*. Z∧*a* = +28°. G. = 3.4	359

Group 24b. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically −

A. No visible cleavage

100 dist.	**Prism.**	0°	Tet.	Dipyre	Sil.	G. = 2.65±. Sol. HF	296
X⊥**001**	**0001**	0°	Hex.	*Metavoltine*	Sul.	X = colorless, Z = orange	114
X⊥**001**	**Lam.**	0°	?	*Saponite*	Sil.	G. = 2.26. Sol. HF	437
110, 001	**Prism.**	70°	Orth.	*Sulfoborite*	Bor.	X = *c*. Y = *b*. G. = 2.4	120

TABLE II.—BIREFRINGENCE OF MINERALS

III. Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 24b. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically −, *continued*							
A. No visible cleavage—*continued*							
$Z \perp 010$ cl.	Prism.	60°±	Orth.	**Cordierite**	Sil.	Ps. Hex. twin. $X = c$. Colorless or X = yel., Y = blue, Z = blue	307
$X \perp$ cleav.	?	Sm.	Orth.	*Centrallasite*	Sil.	G. = 2.5. Sol. HCl	409
$X \wedge c = +30°$	Lam.	25°	Mon.	*Morinite*	Phos.	$Y = b$. G. = 2.94	158
?	Prism.	Mod.	Tr.	*Siderotil*	Sul.	Bl.-green. G. = 2.2. Sol. H_2O	107
?	?	Mod.	Tr.	*Co-Chalcanthite*	Sul.	Pink. G. = 2.2. Sol. H_2O	107
B. One or more visible cleavage directions							
$X \perp 0001$ cl.	0001	0°	Hex.	*Pyroaurite*	Carb.	X = colorless, Z = red	87
$X \perp 0001$ cl.	0001	0°	Rhom.	*Gyrolite*	Sil.	G. = 2.4. Also biax.?	408
$X \perp 001$ cl.	El. ∥ b	68°	Orth.	*Beryllonite*	Phos.	$Y \perp 100$ cl. G. = 2.85	149
$X \parallel 110$ cl.	Ps. Tet.	50°±	Orth.	*Edingtonite*	Sil.	$Y = b$. G. = 2.7	389
$X \perp 001$ cl.	001	Mod.	Mon.	**Antigorite**	Sil.	$Y = b$. G. = 2.57	280
$Z \perp 010$ cl.	El. ∥ c	79°	Mon.	*Pharmacolite*	Arsen.	$X \wedge c = +70°$. G. = 2.7	123
001 perf.	001	?	Mon.	*Volchonskoite*	Sil.	Bl.-green. G. = 2.3	416
010 perf.	Fib.	Lg.	Tr.	*Okenite*	Sil.	$X = c$±. G. = 2.3. Gel. HCl	413
001, 010	a or 010	Lg.	Tr.	**BYTOWNITE**	Sil.	$Z \wedge 010 = 42°$. $Z \wedge 001 = 45°$	376
001, 010	a or 010	Lg.	Tr.	**ANORTHITE**	Sil.	$Z \wedge 010 = 43°$. $Z \wedge 001 = 50°$	378
Group 25a. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +							
A. No visible cleavage							
110 dist.	Prism.	0°	Tet.	*Auerlite*	Ox.	Yellow. G. = 4.5±	185
$11\bar{2}0$ dist.	Prism.	0°	Rhom.	Phenacite	Sil.	G. = 3.0. Sol. HF	185

Y⊥010 cl.	Prism.	45°±	Orth.	Mullite	Sil.	Z=*c*. G.=3.0	201
Z ‖ fib.	Fib.	Lg.	Orth.	*Salmonsite*	Phos.	2 cleav. at 90°. G.=2.9. **X**=colorless, **Z**=orange	156
Z⊥100 cl.±	Prism.	74°	Mon.	*Mosandrite*	Sil.	Y=*b*. G.=3.0	423
Z∧*c*=−44°	010	80°	Mon.	*Hellandite*	Sil.	Y=*b*. Brown to red	425
X⊥010±	Lath.	Lg.	Tr.?	*Uranopilite*	Sul.	Yellow; not pleo. G.=3.9	117
				B. One visible cleavage			
0001 perf.	0001	0°	Rhom.	*Goyazite*	Phos.	Colorless to br. Also biax.	153
0001 perf.	0001	0°	Rhom.	*Svanbergite*	Phos.	G.=3.5. Sol. HCl	119
Z⊥001 cl.	Ps. Hex.	15°	Orth.	*Manandonite*	Sil.	G.=2.9. Sol. HF	95
Z⊥001 cl.	Prism.	60°±	Orth.	Topaz	Sil.	Y=*b*. G.=3.55	198
Z⊥001 cl.±	Ps. Hex.	Sm.	Mon.	Amesite	Sil.	Y=*b*. G.=2.8	285
001 perf.	El. ‖ *b*	55°	Mon.	*Afwillite*	Sil.	X∧*c*=31°. Y=*b*. G.=2.6	412
001, 110	Gran.	60°	Mon.	*Custerite*	Sil.	X=*b*. Z∧*c*=6°. G.=2.9	412
001, 110	Gran.	62°	Mon.	***Cuspidine***	Sil.	Y=*b*. Z∧*c*=5°. G.=2.96	412
X⊥001 cl.±	001	Var.	Mon.	*Nontronite*	Sil.	X=yel., Z=yel., gr., br.	415
010, 100	Eq.	Lg.	Tr.	*Fairfieldite*	Phos.	Ext. in 010 at 10° to *c*	127
				C. Two or more visible cleavage directions			
001, 110	El. ‖ *a*	38°	Orth.	Barite	Sul.	Y=*b*. Z=*a*. G.=4.5	100
Z ‖ 110 cl.	Pyr.	70°	Orth.	*Stokesite*	Sil.	Y=*b*. G.=3.2	409
110 at 56°	Prism.	80°	Orth.	**Anthophyllite**	Sil.	Y=*b*. Z=*c*. G.=3±	240
110 at 87°	Prism.	45°	Mon.	**Clinoenstatite**	Sil.	X=*b*. Y∧=*c*+25°±. G.=3.2	220
110 at 87°	Prism.	Sm.	Mon.	**Pigeonite**	Sil.	X or Y=*b*. Z∧*c*=+30°±	227
110 at 87°	Prism.	70°±	Mon.	Jadeite	Sil.	Y=*b*. Z∧*c*=+32°. G.=3.4	235
110 at 56°	Prism.	Lg.	Mon.	*Kupfferite*	Sil.	Y=*b*. Z∧*c*=+11°. G.=3.1	244

Group 25b. Refringence positive and moderate: N_o or $N_m>1.59<1.66$. Optically −

A. No visible cleavage

X=*c*	0001	0°	Hex.	***Metavoltine***	Sul.	X=yel., Z=orange. G.=2.5	114
X=*c*	Fib.	0°	Hex.	*Crandallite*	Phos.	H.=4. Decrep.	154

TABLE II.—BIREFRINGENCE OF MINERALS

III. Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$—*continued*

Group 25b. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically −, *continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
				A. No visible cleavage—*continued*			
$X=c$	Fib.	0°	Hex.	*Dahllite*	Phos.	G.=3.0. Also biax.	161
$X=c$	Prism.	0°	Hex.	**Tourmaline**	Sil.	Colorless or X=colorless, Z=pink or blue. G.=3.1	301
110 at 89°	Prism.	84°	Orth.	**Andalusite**	Sil.	$X=c$. $Y=b$. G.=3.1–3.2	201
X ‖ elong.	Fib.	?	Orth.	*Koninckite*	Phos.	G.=2.4. Sol. HCl	142
$X=c$	Ps. Hex.	Sm.	Orth.	*Eremeyevite*	Bor.	c ‖ elong. G.=3.28	94
100?	?	Lg.	Mon.	*Crestmorite*	Sil.	$Z \wedge$ elong.=12°. G.=2.2	409
$X \wedge c = 30°$	El. ‖ b	Lg.	Mon.	**Allanite**	Sil.	X=yel., Y=br., Z=red-br.	316
100 dist.	Prism.	74°	Mon.	*Hureaulite*	Phos.	$X=b$. $Z \wedge c = +75°$. G.=3.2	124
				B. One visible cleavage			
X⊥001 cl.	Ps. Tet.	10°	Orth.	*Uranocircite*	Arsen.	X=colorless, Y, Z=yel. G.=3.5	147
X⊥001 cl.	Ps. Tet.	Sm.	Orth.	*Torbernite*	Phos.	X=green, Z=yel. G.=3.2	145
X⊥001 cl.	001	0°±	Mon.	*Ectropite*	Sil.	$Y=b$. $Z=a$±. G.=2.46	409
X⊥001 cl.±	001	Sm.	Mon.	*Chamosite*	Sil.	X=yel., Y, Z=green. G.=3	286
X⊥001 cl.±	001	Sm.	Mon.	Glauconite	Sil.	X=yel., Y, Z=green. G.=2.5±	436
X⊥001 cl.±	001	Sm.	Mon.	Celadonite	Sil.	X=yel.-gr., Y, Z=green	436
X⊥001 cl.±	001	Sm.	Mon.	*Seybertite*	Sil.	X=colorless, Y, Z=yel. G.=3.1	286
X⊥001 cl.±	001	20°±	Mon.	*Xanthophyllite*	Sil.	X=brown, Y, Z=green. G.=3.1	286
X⊥001 cl.±	001	25°+	Mon.	*Brandisite*	Sil.	X=yel., Y, Z=gr. G.=3.1	286
X⊥001 cl.±	001	35°	Mon.	*Margarite*	Sil.	$Z=b$. G.=3.0–3.1	288

				C. Two or more visible cleavage directions			
100, 001	100, 001	70°	Mon.	**Wollastonite**	Sil.	$X \wedge c = -32°$. $Y = b$. G. = 2.9	401
$X \perp 100$ cl. ±	100	49°	Mon.	*Spencerite*	Phos.	$Z \perp 010$ cl. G. = 3.1. Sol. HCl	137
110 at 56°	Prism.	45° ±	Mon.	Glaucophane	Sil.	$Y = b$. $Z \wedge c = +5°$. G. = 3.1. X = colorless, Y = blue, Z = lavender	258

Group 26a. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +

				A. No visible cleavage and parallel extinction in the chief zones			
$Z \parallel$ elong.	Fib.	?	?	*Stibiconite*	Ox.	G. = 5.2. Insol.	68
$Y \perp 010$ cl.	Prism.	45° +	Orth.	Mullite	Sil.	$Z = c$. G. = 3	201
001, 012	Prism.	70°	Orth.	*Barylite*	Sil.	$X = b$. $Y = a$. G. = 4.0	401
010, 100?	Fib.	Lg.	Orth.	*Salmonsite*	Phos.	$Z = c$. X = colorless, Z = orange	156
$Y = a$?	Ps. Is.	83°	Orth.	*Boracite*	Bor.	G. = 2.95. Sol. HCl. Isom. above 265° C.	94
				B. No visible cleavage and inclined extinction in the chief zones			
$X \perp 010$ cl.	Prism.	23°	Mon.	*Brandtite*	Arsen.	$Y \wedge c = +8°$. G. = 3.6	125
100 dist.	100	43°	Mon.	*Rinkite*	Sil.	$X = b$. $Y \wedge c = -8°$. G. = 3.5	423
$Z \perp 100$ cl. ±	100	70°	Mon.	*Johnstrupite*	Sil.	$Y = b$. Lam. twin. G. = 3.3	423
$Z \wedge 001$ cl. = 20°	100	85° ±	Mon.	**Clinozoisite**	Sil.	$Y = b$. G. = 3.35. Sol. HF	312
001, 011	El. $\parallel b$	Lg.	Tr.	*Johannite*	Sul.	Green. G. = 3.3	118
$Z \perp 010$ cl. ±	Prism.	Lg.	Tr.	*Hainite*	Sil.	Yel.; pleo. G. = 3.2	406
110 at 90° ±	100	90° ±	Tr.	*Guarinite*	Sil.	Yel.; pleo. G.3.3	406
				C. One visible cleavage			
$X \perp 001$ cl.	Fib.	Lg.	Orth.	*Pumpellyite*	Sil.	$Y \parallel$ fibers. X, Z = colorless, Y = green	432
$Y \perp 001$ cl.	Prism.	65°	Orth.	Lithiophilite	Phos.	$Z \perp 010$ cl. G. = 3.5	149
001, 010	?	72°	Orth.	*Natrophilite*	Phos.	$Y = c$. $Z = b$. Yel. G. = 3.4	150
One $\parallel$ elong.	?	18°	Mon.	*Lotrite*	Sil.	Green in mass. G. = 3.2	433
$Y \perp 001$ cl. ±	001	Mod.	Mon.	*Dickinsonite*	Phos.	$X = b$. Olive: $X > Y > Z$. G. = 3.3	122
$Z \perp 001$ cl. ±	001	50° ±	Mon.	***Sismondine***	Sil.	$Y = b \pm$. X = gr., Y = bl., Z = yel.-gr.	438
$Z \perp 010$ cl.	?	67°	Mon.	***Merwinite***	Sil.	$X \wedge c = 36°$. G. = 3.15	194
$X \perp 100$ cl. ±	?	Mod.	Tr.	*Roselite*	Arsen.	X, Y = pink, Z = colorless	127
$Z \perp 001$ cl. ±	001	50° ±	Tr.	Chloritoid	Sil.	Bl.-green; pleo. G. = 3.5	438

TABLE II.—BIREFRINGENCE OF MINERALS

III. Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
				Group 26a. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +, *continued*			
				D. Two or more visible cleavage dirctions			
001, 110	001 or *a*	40°±	Orth.	*Barite (Pb)*	Sul.	$Y = b$. $Z = a$. G. = 5±	100
$X = b$. $Y = c$	Prism.	Mod.	Orth.	***Titano-elpidite***	Sil.	Yellow: $X < Y$. G. = 2.55	400
110 at 88°	Prism.	70°±	Orth.	**ENSTATITE**	Sil.	$Y = b$. $Z = c$. G. = 3.3±	217
110 at 87°	Prism.	Sm.	Mon.	**Pigeonite**	Sil.	X or $Y = b$. $Z \wedge c = +30°$±	227
110 at 87°	Prism.	45°±	Mon.	**Clinoenstatite**	Sil.	$X = b$. $Z \wedge c = +25°$. G. = 3.2	220
110 at 87°	Prism.	60°	Mon.	**Hedenbergite**	Sil.	$Y = b$. $Z \wedge c = 48°$. Green: $X < Y < Z$	224
110 at 87°	Prism.	60°±	Mon.	Spodumene	Sil.	$Y = b$. $X \wedge c = +25°$±. Tinted ±	236
110 at 87°	Prism.	70°	Mon.	Jadeite	Sil.	$Y = b$. $Z \wedge c = +30°$±. G. = 3.4	235
				Group 26b. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically −			
				A. No visible cleavage and uniaxial			
$X \perp 001$ cl.	Prism.	0°	Tet.	**Gehlenite**	Sil.	G. = 3.0. Gel. HCl	209
$X \perp 001$ cl.	Prism.	0°	Tet.	*Hardystonite*	Sil.	G. = 3.4. Gel. HCl	209
$X \perp 001$ cl.	Prism.	0°	Tet.	*Justite*	Sil.	G. = 3.1. Gel. HCl	209
$X = c$	0001	0°	Rhom.	*Melanocerite*	Sil.	G. = 4.1. Dec. HCl. Yellow	420
				B. No visible cleavage and biaxial			
$X \parallel 110$ cl.	Prism.	20°	Orth.	***Kornerupine***	Sil.	$Y = a$. G. = 3.3	421
$Z \perp 100$ cl.	Fib.	30°	Orth.	Dumortierite	Sil.	Blue; pleo. $Y = b$. G. = 3.3	422
$X = c$; $Y = b$	Prism.	Mod.	Orth.	*Kempite*	Hal.	Green. G. = 2.9	39
One dist.	Prism.	Mod.	Orth.	*Cenosite*	Sil.	Yellow. G. = 3.4	440
$X = b$; $Y = c$	Prism.	75°	Orth.	Monticellite	Sil.	G. = 3.2. Gel. HCl	187

$Y\wedge c=-2°$	100	70°	Mon.	*Thalenite*	Sil.	Z=*b*. G.=4.3	414
$X\wedge c=30°$	El. ∥ *b*	Lg.	Mon.	**Allanite**	Sil.	Green or brown: X<Z	316
100 dist.	El. ∥ *b*	83°	Mon.	*Chlorophoenicite*	Arsen.	Y=*b*. G.=3.5	134
$\bar{1}12$, $1\bar{3}0$	Wedge	73°	Tr.	**Axinite**	Sil.	X⊥011±. Yel., violet, etc.	425
X⊥001 cl.±	Ps. Hex.	83°	Tr.	*Trimerite*	Sil.	G.=3.5. Sol. HCl	401

C. One or more visible cleavage directions

X⊥001 cl.	001	0°±	Tet.	*Sincosite*	Phos.	X=yel., Z=green. G.=2.8	147
110 at 88°	Prism.	75°±	Orth.	**HYPERSTHENE**	Sil.	X=*a*. Y=*b*. X=red, Y=br., Z=gr.	219
X⊥001 cl.±	001	20°	Mon.	*Xanthophyllite*	Sil.	X=brown, Y, Z=green. G.=3.1	286
X⊥001 cl.±	001	25°	Mon.	*Brandisite*	Sil.	X=yel., Y, Z=green. G.=3.1	286
X⊥100 cl.±	100	63°	Mon.	*Tinzenite*	Sil.	Y=*b*. Green: X>Y>Z.	428
$Z\wedge 001$ cl.=25°	El. ∥ *b*	80°±	Mon.	**EPIDOTE**	Sil.	Golden: Y>Z>X. G.=3.3	314
110 at 88°	Prism.	Lg.	Mon.	**Clinohypersthene**	Sil.	X=*b*. $Z\wedge c=+30°$±. G.=3.4	221
Z⊥010 cl.	Var.	Lg.	Mon.	*Clinohedrite*	Sil.	$Y\wedge c=-28°$. G.=3.3	413
010, 110	Prism.	44°	Tr.	*Bustamite*	Sil.	X⊥010±. $Z'\wedge c=36°$ on 010	406
X⊥100 cl.±	El. ∥ *c*	83°	Tr.	**Kyanite**	Sil.	100 lam. twin. G.=3.6	205

Group 27a. Refringence positive and very high: N_o or $N_m>1.74<2.00$. Optically +

A. No visible cleavage

Z ∥ 110 cl.	Prism.	0°	Tet.	*Thorite*	$ThSiO_4$	Yellow. G.=5.3	185
111 dist.	Pyr.	0°	Tet.	Scheelite	$CaWO_4$	G.=6.1	97
111 dist.	Pyr.	0°	Tet.	*Powellite*	$CaMoO_4$	Yellow. G.=4.4	98
Z⊥0001 cl.	Prism.	0°	Hex.	*Nasonite*	Sil.	G.=5.4. Sol. HCl	407
Z ∥ fib.	Fib.	?	Orth.	*Stibiconite*	Ox.	G.=5.2. Insol.	68
Y=*b*. Z=*a*	100	30°	Orth.	*Holdenite*	Arsen.	G.=4. Pink	136
Y=*b*. Z=*c*	100	55°	Orth.	*Chrysoberyl*	Ox.	Colorless or pleo.; red, gr.	65
X⊥010 cl.	Prism.	85°	Orth.	**Staurolite**	Sil.	Z=*c*. Yellow: X<Y<Z	202
$X\wedge c$=Sm.	010	0°±	Mon.	*Huegelite*	Van.	Z=*b*. Yellow; pleo. G.=5	127
No cleav.	Eq.	Mod.	Mon.	*Barthite*	Arsen.	Green. G.=4.2	160
$Z\wedge c=+8°$	Prism.	85°	Mon.	*Gadolinite*	Sil.	Y=*b*. Gr. or br. G.=4.3	424

TABLE II.—BIREFRINGENCE OF MINERALS

III. Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 27a. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +, *continued*							
B. One or more visible cleavage directions							
010, 110	Prism.	35°±	Orth.	*Ardennite*	Sil.	Y=*b*. Z=*c*. Yellow: X>Y>Z	440
001, 110	Var.	70°±	Orth.	Anglesite	$PbSO_4$	Y=*b*. Z=*a*. G.=6.3	99
110 at 87°	Prism.	60°	Mon.	**Hedenbergite**	Sil.	Y=*b*. $Z \wedge c = +48°$. Green: X<Y<Z	224
110 at 87°	Prism.	30°	Tr.	*Pyroxmangite*	Sil.	Opt. Pl.⊥010±. G.=3.8	406
Z⊥001 cl.±	001	50°±	Tr.	Chloritoid	Sil.	Green, blue; pleo. G.=3.5	438
Z⊥001 cl.±	001	50°+	Tr.	*Sismondine*	Sil.	Green, blue; pleo. G.=3.4	438
110, $1\bar{1}0$	Prism.	Lg.	Tr.	Rhodonite	Sil.	G.=3.5. Sol. HF	403
Group 27b. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically −							
X=*c*	0001	0°	Hex.	*Dussertite*	Arsen.	G.=3.75. Sol. HCl. Yel.-green. X<Z	153
No cleav.	?	Mod.	Mon.	*Chevkinite*	Sil.	Brown: X<Y<Z. G.=4.5	423
Group 28a. Refringence positive and extreme: N_o or $N_m > 2.00$. Optically +							
Z=*c*?	?	0°	Tet.	*Strueverite*	Tit.	X=br., Z=gr. to opaque	164
Z⊥0001 cl.	Prism.	0°	Hex.	*Iodyrite*	AgI	Yel. Abn. int. colors	30
Group 28b. Refringence positive and extreme: N_o or $N_m > 2.00$. Optically −							
X=*c*?	?	0°	Tet.	*Strueverite*	Tit.	X=gr. to opaque; Z=br.	164
X=*c*	Prism.	0°	Hex.	Pyromorphite	Phos.	Colorless or X=yel., Z=gr.	131
X=*c*	Prism.	0°	Hex.	*Mimetite*	Arsen.	Colorless or yel.: X<Z	132
$10\bar{1}1$ dist.	Prism.	0°	Hex.	*Finnemanite*	Arsen.	Olive green. G.=7.3	159
X=*c*	?	0°	Rhom.	*Senaite*	Ox.	Nearly opaque. G.=5.±	67
X⊥plates	Platy	Sm.	Mon.	*Montanite*	Tel.	Abn. int. colors. G.=3.8	109

IV. Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$

Group 29a. Refringence negative and distinct: N_o or $N_m < 1.48$. Optically +

$Y=b$. $Z=a$	Ps. Hex.	70°	Orth.	Carnallite	Hal.	G.=1.6. Sol. H_2O	34
$Y \perp 001$ cl.	Var.	83°	Orth.	*Thenardite*	Sul.	$Z=a$. G.=2.7. Sol. H_2O	96

Group 29b. Refringence negative and distinct: N_o or $N_m < 1.48$. Optically −

$X=c$	Fib.	0°	?	*Mendozite*	Sul.	G.=1.7. Sol. H_2O	113
100, 110	Prism.	40°	Mon.	Borax	Bor.	$X=b$. $Z \wedge c=-55°$. G.=1.7	90
?	Fib.	48°	Mon.	*Wattevillite*	Sul.	G.=1.8. Sol. HCl	112
100 perf.	Prism.	64°	Mon.	*Creedite*	Sul.	$Y=b$. $Z \wedge c=42°$. Purple ±	121

Group 30a. Refringence negative and low: N_o or $N_m > 1.48 < 1.54$. Optically +

$Z=c$	?	0°	?	*Ozocerite*	H, C	Also biax. G.=0.9	18
$Y=b$. $Z=a$	Prism.	78°	Orth.	*Flagstaffite*	H, C, O	G.=1.1. Sol. alcohol	88
$Y \perp 010$	100	45°	Orth.	*Newberyite*	Phos.	$Z=c$. G.=2.1. Sol. HNO_3	123
$Z \perp 010$ cl.	Prism.	54°±	Orth.	Thomsonite	Sil.	$Y=c$. G.=2.3. Gel. HCl	387
101, 010	Fib.	72°	Orth.	Wavellite	Phos.	$Y=a$. $Z=c$. G.=2.3. Sol. HCl	144
$Y \perp 100$ cl.	Acic.	74°	Orth.	*Tavistockite*	Phos.	$Z=c$. Sol. HCl	154
$Y \wedge c=23°$	El. ∥ c	Mod.	Mon.	Ulexite	Bor.	$Z=b$. G.=1.8±. "Cotton balls"	93
$Z \perp 010$ cl.	El. ∥ c	Mod.	Mon.	*Hydromagnesite*	Carb.	$Y \wedge c=43°$. 100 twin. G.=2.1	85
$Z \perp 010$ cl.	Eq.	35°	Mon.?	*Wapplerite*	Arsen.	$Z=b$±. G.=2.5	124

Group 30b. Refringence negative and low: N_o or $N_m > 1.48 < 1.54$. Optically −

A. No visible cleavage

$X \perp 001$ cl.	?	0°	Tet.	*Loewite*	Sul.	G.=2.4. Sol. H_2O	111
$X=c$	?	0°	Tet.?	*Bechilite*	Bor.	Doubtful species	92
$X \perp 0001$ cl.	Var.	0°	Hex.	*Hanksite*	Sul.	G.=2.56. Sol. H_2O	119
$X=c$	Acic.	0°	Hex.	*Nocerite*	Hal.	G.=2.96	38
$X=c$	0001	0°	Hex.	*Zincaluminite*	Sul.	G.=2.26. Sol. HCl	115
100, 110	Tab.	85°	Mon.	*Kainite*	Sul.	$X \wedge c=-8°$. $Y=b$. G.=2.13	120

TABLE II.—BIREFRINGENCE OF MINERALS

IV. Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 30b. Refringence negative and low: N_o or $N_m > 1.48 < 1.54$. Optically −, *continued*							
A. No visible cleavage—*continued*							
001 dist.	Tab.	70°	Mon.	*Inyoite*	Bor.	$X \wedge c = +37°$. $Y = b$. G. = 1.88	92
110 at 73°	001	Mod.	Mon.	*Lueneburgite*	Phos.	$Y = b$? $Z \wedge c = 45°$. G. = 2	161
?	Prism.	60°	Tr.	*Fe-Cu-chalcanthite*	Sul.	Pale blue. G. = 2.1	107
B. One or more visible cleavage directions							
$10\bar{1}0$ perf.	Prism.	0°	Hex.	Cancrinite	Sil.	G. = 2.5. Gel. HCl	301
0001 perf.	0001	0°	Hex.	*Stichtite*	Carb.	Lilac: X < Z. G. = 2.16	87
$X \perp 010$ cl.	Acic.	42°	Orth.	*Morenosite*	Sul.	Greenish. G. = 2	103
$X \perp 001$ cl.±	001	Sm.	Mon.	**Antigorite**	Sil.	Greenish. $N_m = 1.57$ usually	280
001 perf.	El. ‖ c	7°	Mon.	Glauberite	Sul.	$X \wedge c = +31°$. $Z = b$. G. = 2.85	110
100 perf.	El. ‖ c	Mod.	Mon.	*Searlesite*	Sil.	$X \wedge c = +30°$. $Z = b$. G. = 2.45	423
$X \perp 010$ cl.	El. ‖ c	Lg.	Mon.	*Minasragrite*	Sul.	Blue: X > Y > Z. Sol. H_2O	110
Group 31a. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically +							
A. No visible cleavage							
$Z \perp 0001$ cl.	0001	0°	Rhom.	*Alunite*	Sul.	G. = 2.6	113
$Z = c$	Ps. Is.	0°	Rhom.	*Alumianite*	Sul.	G. = 2.74. Sol. HCl	107
Z ‖ fib.	Fib.	?	?	*Zepharovichite*	Phos.	G. = 2.37. Sol. Cl	141
Z ‖ fib.	Fib.	Sm.	Orth.	*Xylotile*	Sil.	Yellow: X = Y < Z. G. = 2.5	261
?	Mass.	49°±	Orth.	*Norbergite*	Sil.	G. = 3.4. Gel. HCl	196
$Z \perp 100$±	100	Lg.	Mon.	*Martinite*	Phos.	$Y = b$. G. = 2.9. Sol. HCl	124
010 dist.	Prism.	35°	Tr.	*Paravauxite*	Phos.	On 010 $Y' \wedge c = 38°$	157

B. One or more visible cleavage directions

Z⊥0001 cl.	0001	0°	Rhom.	Brucite	$Mg(OH)_2$	G.=2.4. Sol. HCl	42
Z⊥010 cl.	Prism.	54°±	Orth.	Thomsonite	Sil.	Y=*c*. G.=2.3. Gel. HCl	387
101, 010	Fib.	72°	Orth.	Wavellite	Phos.	Y=*a*. Z ‖ fib. G.=2.33	144
Y⊥001 cl.	Acic.	74°	Orth.	*Tavistockite*	Phos.	Z=*c*. Sol. HCl	154
001 perf.	001	Sm.	Mon.	Gibbsite	$Al(OH)_3$	X (or Y)=*b*. Z∧*c*=30°±. G.=2.35	48
010 perf.	Eq.	35°	Mon.?	*Wapplerite*	Arsen.	Z=*b*. Ext. on 010=20°	124
X⊥lam.±	Lam.	60°	Tr.?	*Voglite*	Carb.	Z∧elong.=33°. Lam. twin.	88

Group 31b. Refringence positive and low: N_o or $N_m>1.53<1.59$. Optically −

A. No visible cleavage

100 dist.	El. ‖ *c*	0°	Tet.	Dipyre	Sil.	G.=2.65. Sol. HF	296
X=*c*	?	0°	Tet.?	*Bechilite*	Bor.	Doubtful species	92
X=*c*	0001	0°	Hex.	*Zincaluminite*	Sul.	G.=2.26. Sol. HNO_3	115
X ‖ fib.	Fib.	Sm.	?	*Ascharite*	Bor.	G.=2.7	92
Z=*c* ?	Fib.	55°±	Orth.	*Variscite*	Phos.	G.=2.54. Tinted±	140
One dist.	Fib.	?	Orth.	*Spherite*	Phos.	G.=2.54	144
110 at 73°	001	Mod.	Mon.	*Lueneburgite*	Phos.	G.=2. Sol. HCl	161
?	?	Mod.	Tr.	*Co-chalcanthite*	Sul.	Pink. G.=2.2	107
?	?	60°	Tr.	*Fe-Cu-chalcanthite*	Sul.	Pale blue. G.=2.2	107
One dist.	Fib.	60°	Tr.	Polyhalite	Sul.	Ext. on cleav. at 20° and 29°	113

B. One visible cleavage and parallel extinction

0001 perf.	0001	0°	Hex.	*Stichtite*	Carb.	Lilac: X<Z. G.=2.16	87
X⊥001 cl.±	001	33°	Orth.	*Autunite*	Phos.	X=colorless; Y, Z=yellow	146
X±001 cl.±	001	46°	Orth.	*Uranospinite*	Arsen.	X=colorless; Y, Z=yellow	147
X⊥001 cl.±	001	Sm.	Mon.	**Lepidolite**	Sil.	Z=*b*. Colorless, pink, violet	270
X⊥001 cl.±	001	0°±	Mon.	Jefferisite	Sil.	X=colorless; Y, Z=brown	433
X⊥001 cl.±	001	Sm.	Mon.	Bowlingite	Sil.	X=yel., Y, Z=gr. or brown	437
Z⊥001 cl.±	001	Sm.	Mon.	*Canbyite*	Sil.	Golden br., not pleo. G.=3±	415
X⊥001 cl.±	001	Var.	Mon.	*Nontronite*	Sil.	X=yel., Y=olive, Z=gr. G.=2.5	415

TABLE II.—BIREFRINGENCE OF MINERALS

IV. Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 31b. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically −, *continued*							
C. One visible cleavage and inclined extinction							
X⊥001 cl.±	001	Sm.	Mon.	**Lepidolite**	Sil.	$Z=b$. Colorless, pink, violet	270
001 perf.	001	Sm.	Mon.	Glauberite	Sul.	$X \wedge c = +31°$. $Z=b$. G.=2.85	110
100 perf.	?	Mod.	Mon.	*Searlesite*	Sul.	$X \wedge c + 30°$. $Z=b$. G.=2.45	423
X⊥010 cl.	010	62°	Mon.	*Bassetite*	Phos.	Yel.: $X<Y=Z$. G.=3.1	146
X⊥010 cl.	El. ∥ c	Lg.	Mon.	*Minasragrite*	Sul.	$Z \wedge c = 12°$. Blue: $X>Y>Z$	110
$X=b$±	Prism.	42°	Tr.	*Hannayite*	Phos.	$Y \wedge c = 33°$. G.=1.89	151
Group 32a. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +							
A. No visible cleavage							
$Z=c$	?	0°	?	*Plumbogummite*	Phos.	Yellow: $X<Z$. G.=4.5±	153
$X=c$	Fib.	Sm.	Orth.	*Roeblingite*	Sil.	G.=3.4. Sol. HCl	440
$Yb.=Z=a$±	100	Lg.	Mon.?	*Martinite*	Phos.	G.=2.9. Sol. HCl	124
$Y \wedge c = 1°$?	001	Sm.±	Mon.	*Homilite* (alt.)	Sil.	Yel. G.=3.3±. Sol. HCl	424
B. One visible cleavage							
X⊥010 cl.	?	Lg.	Orth.	*Kreuzbergite*	Phos.	$Y=c$. G.=2.14	141
Y⊥010 cl.	Prism.	28°±	Orth.	**Sillimanite**	Sil.	$Z=c$. G.=3.25	200
Y⊥010 cl.	Prism.	50°±	Mon.	*Euclase*	Sil.	$Z \wedge c = +41°$. G.=3	432
X⊥001 cl.±		Lg.	Mon.	*Fremontite*	Phos.	G.=3	152
100 perf.	?	Lg.	Mon.	*Triplite*	Phos.	$Y=b$. $Z \wedge a = 42°$. Pink to br.	134
001, 100	?	80°±	Tr.	Montebrazite	Phos.	G.=3.0. Sol. H_2SO_4	152
010 perf.	100	90°±	Tr.	*Parahopeite*	Phos.	$X=a$±. G.=3.3. Sol. HCl	128

C. Two visible cleavages

110 at 76°	Var.	46°	Orth.	Hemimorphite	Sil.	Y=*a*. Z=*c*. G.=3.45	211
110 at 54°	Fib.	80°±	Orth.	**Anthophyllite**	Sil.	Y=*b*. Z=*c*. Colorless or tinted	240
110 at 56°	Prism.	60°	Mon.	**Pargasite**	Sil.	Y=*b*. Z∧*c*=+27°. Colorless or X=yel., Y=gr., Z=gr.-blue	247
110 at 56°	Prism.	85°±	Mon.	Cummingtonite	Sil.	Y=*b*. Z∧*c*=+16°. Colorless or X, Y=yel., Z=br. G.=3.2±	243

Group 32b. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically −

A. No visible cleavage

X⊥001 cl.	Pyr.	0°	Tet.	*Meliphanite*	Sil.	Yellow±. G.=3	210
X=*c*	Prism.	0°	Hex.	*Bazzite*	Sil.	X=blue, Z=yel. G.=2.8	414
X=*c*	Prism.	0°	Hex.	Tourmaline (Li)	Sil.	Colorless or yel.: X<Z	301
X=*c*	Prism.	0°	Hex.	**Tourmaline (Mg)**	Sil.	Colorless, pink or blue: X<Z	301
X⊥cleav.	Platy	30°	Orth.	*Astrolite*	Sil.	X=colorless, Y, Z=gr. G.=2.8	429
Z=*c*?	Fib.	Sm.	?	Chrysocolla	Sil.	X=gr., Z=colorless. G.=2.4±	411
X⊥001 cl.±	001	Sm.	Mon.	*Bityite*	Sil.	G.=3. Sol. HF	427
Z∧*c*=44°	100	Lg.	Mon.	*Howlite*	Bor.	Y=*b*. G.=2.58	95
X∧*c*=35°±	El. ‖ *b*	Lg.	Mon.	**Allanite**	Sil.	Brown: X<Y<Z. Sol. HCl	316
100	El. ‖ *b*	60°±	Tr.	Polyhalite	Sul.	Lam. twin.	113

B. One visible cleavage and uncolored

Z⊥100 cl.	Prism.	36°	Orth.	α-Hopeite	Phos.	X⊥010 cl. G.=3.0	124
X⊥001 cl.	Ps. Tet.	39°	Orth.	*Leucophanite*	Sil.	Y=*a*. 110 or 001 twin.	210
X⊥010 cl.	Fib.	60°	Orth.	*Carpholite*	Sil.	Colorless or yel.: X, Y>Z	431
Z⊥001 cl.	Platy	74°	Orth.	*Bertrandite*	Sil.	Y=*b*. G.=2.6	410
X⊥100 cl. ±	Platy	50°	Mon.	*Phosphophyllite*	Phos.	Z=*b*. Y∧*c*=50°±. G.=3.	125
001, 110	Platy	32°	Tr.?	*Priceite*	Bor.	X∧⊥plate=25°. G.=2.4	93
001, 100	?	50°	Tr.	Amblygonite	Phos.	X in 1$\bar{1}$0. G.=3.1	162

C. One visible cleavage and colored

X⊥001 cl.	Ps. Tet.	0°±	?	*Zeunerite*	Arsen.	Green: X<Z. G.=3.2	146
X⊥001 cl.	001	0°±	Orth.	*Bementite*	Sil.	Brown or gray: X<Y, Z	409

TABLE II.—BIREFRINGENCE OF MINERALS

IV. Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
				Group 32b. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically −, *continued*			
				C. One visible cleavage and colored −, *continued.*			
X⊥001 cl.	Ps. Tet.	33°	Orth.	*Autunite*	Phos.	Golden: X<Y=Z. G.=3.1	146
X⊥010 cl.	Fib.	60°	Orth.	*Carpholite*	Sil.	Colorless or yel.: X, Y>Z	431
X⊥001 cl.±	001	Sm.	Mon.	Bowlingite	Sil.	Yel., gr., br.; pleo. G.=3±	437
X⊥001 cl.±	001	Var.	Mon.	*Nontronite*	Sil.	Yel., gr., br.; pleo. G.=2.5	415
001 perf.	001	Lg.	Mon.	*Roscherite*	Phos.	X=yel.; Y, Z=br. G.=2.9	156
				D. Two or more visible cleavage directions			
110 at 55°	Fib.	80°	Orth.	*Gedrite*	Sil.	Y=*b*. Z=*c*. G.=3.0	240
110 at 56°	Prism.	43°	Mon.	*Gastaldite*	Sil.	Like glaucophane	259
110 at 56°	Prism.	45°±	Mon.	Glaucophane	Sil.	Y=*b*. Z∧*c*=+5°. G.=3.1. X=yel., Y=violet, Z=blue	258
110 at 56°	Prism.	80°±	Mon.	**HORNBLENDE**	Sil.	Y=*b*. Z∧*c*=+20°±. G.=3.1±. X=yel., Y, Z=gr. or br.	247
110 at 56°	Prism.	80°±	Mon.	**Actinolite**	Sil.	Y=*b*. Z∧*c*=+14°. G.=3.1	245
110 at 56°	Prism.	85°±	Mon.	**Tremolite**	Sil.	Y=*b*. Z∧*c*=+17°. G=2.9	245
				Group 33a. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +			
				A. No visible cleavage			
Z=*c*	Acic.	0°	Hex.	*Connellite*	Sul.	Blue±. G.=3.4	118
0001, 11$\bar{2}$0	Prism.	0°	Rhom.	Willemite	Sil.	G.=4±. Sol. HCl	186
010, 100	Prism.	Lg.	Orth.	*Shannonite*	Sil.	X=*c*. Y=*a*.	195
X=*b*	Lam.	55°	Mon.	*Graftonite*	Phos.	G.=3.67. Sol. HCl	122
Y∧*c*=−1°	001	8c°	Mon.	*Homilite*	Sil.	Z=*b*. Brown±. G.=3.36	424
Z∧*c*=+39°	001	Lg.	Mon.	*Adelite*	Arsen.	Y=*b*. G.=3.75. Sol. HNO_3	134

B. One or more visible cleavage directions and parallel extinction in chief zones

Z⊥0001 cl.	Rhom.	Sm.	?	*Hinsdalite*	Sul.+	G.=4.65. Insol. HCl	119
Z⊥001 cl.	Pyr.	Sm.	Orth.	*Strengite*	Phos.	Colorless, pink, blue: X,Y<Z	140
110 at 55°	Fib.	80°	Orth.	**Anthophyllite**	Sil.	Y=*b*. Z=*c*. G.=3±	240
010, 001	Prism.	84°	Orth.	Lawsonite	Sil.	X=*a*. Y=*b*. G.=3.1	430

C. One or more visible cleavage directions and inclined extinction

110 at 87°	Prism.	59°	Mon.	**AUGITE**	Sil.	Y=*b*. Z∧*c*=44°±. Colorless±	228
110 at 87°	Prism.	60°	Mon.	**Hedenbergite**	Sil.	Y=*b*. Z∧*c*=47°. Gr.: X<Y<Z	224
110 at 87°	Prism.	60°	Mon.	**DIOPSIDE**	Sil.	Y=*b*. X∧*c*=42°±. Colorless or Y=brownish; X, Z=greenish	224
100 perf.	?	Lg.	Mon.	*Triplite*	Phos.	Y=*b*. Z∧*c*=42°. Pink, br.: X>Y>Z	134
110 at 87°	Prism.	75°±	Mon.	*Jadeite-diopside*	Sil.	Y=*b*. Z∧*c*=45°±. G.=3.3	235
110 at 55°	Prism.	85°±	Mon.	Cummingtonite	Sil.	Y=*b*. Z∧*c*=17°±. Yel.: X, Y<Z	243
110, 1$\bar{1}$0	001	Mod.	Tr.	Rhodonite	Sil.	G.=3.4±. Sol. HF	403
110, 1$\bar{1}$0	001	41°	Tr.	*Sobralite*	Sil.	X∧*c*=63°. Z∧*c*=46°	406

Group 33b. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically −

A. No visible cleavage

Z=*c*	Prism.	32°	Orth.	*Uranophane*	Sil.	Yellow: X<Y<Z. G.=3.9	441
X∧*c*=35°	100	Lg.	Mon.	**Allanite**	Sil.	Gr. or br. G.=4±	316
Z⊥010 cl.	Prism.	75°±	Mon.	*Woehlerite*	Sil.	Yel.: X, Y<Z. X∧*c*=45°.	441
Y=*b*	Prism.	Sm.	Mon.	*Chalcomenite*	Sel.	Blue. G.=3.76	118

B. One visible cleavage

X⊥001 cl.	Mass.	0°	Tet.?	*Schallerite*	Sil.	G.=3.37. Sol. HCl	440
Z⊥001?	?	?	?	*Vilatéite*	Phos.	X=violet, Z=blue. G.=2.75	140
Z⊥001 cl.	001	Lg.	Orth.	*Gerhardtite*	Nit.	X, Y=gr.; Z=blue. G.=3.4	89
X⊥001 cl.±	001	0°±	Mon.	*Strigovite*	Sil.	Green: X<Y, Z. G.=3.1	437
001 perf.	Prism.	25°	Mon.	*Ganophyllite*	Sil.	X∧*c*=2°. Z=*b*. C.=2.84	436
001 perf.	001	85°±	Mon.	**EPIDOTE**	Sil.	Golden: X<Y. G.=3.3	314

TABLE II.—BIREFRINGENCE OF MINERALS

IV. Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 33b. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically −, *continued*							
C. Two or more visible cleavage directions							
X⊥0001 cl.	Rhom.	0°	Rhom.	*Hematolite*	Arsen.	Yel. to br. G.=3.4	153
110 at 56°	Prism.	40°±	Mon.	Barkevikite	Sil.	Y=*b*. Z<*c*=12°±. Brown: X<Y<Z	254
110 at 56°	Prism.	80°±	Mon.	**HORNBLENDE**	Sil.	Yel. to gr. or br. Z∧*c*=20°±	247
Group 34a. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +							
Z⊥0001 cl.	Prism.	0°	Hex.	*Nasonite*	Sil.	G.=5.4. Sol. HCl	407
Z‖ fib.	Fib.	Sm.	Orth.	*Conichalcite*	Arsen.	X=*c*. Y=*b*. G.=4.15	136
010 perf.	Prism.	35°±	Orth.	*Ardennite*	Sil.	Y=*a*. G.=3.6	440
Z⊥100 cl.	Prism.	59°±	Orth.	*Warwickite*	Bor.	Brown: X>Y>Z. G.=3.4	95
Y=*b*. Z=*a*	Prism.	Lg.	Orth.	*Retzianite*	Arsen.	Brown: X<Y<Z. G.=4.15	154
?	?	?	?	*Cervantite*	Ox.	G.=4. Sol. HCl	67
Z∧*c*=12°	Prism.	85°	Mon.	*Gadolinite*	Sil.	Y=*b*. G.=4.3±. Sol. HCl	424
?	?	?	?	*Chenevixite*	Arsen.	Green. G.=3.9. Sign ?	156
Group 34b. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically −							
X=*c*	Prism.	0°	Hex.	*Cappelenite*	Sil.	Gr.-brown. G.=4.4	420
001, 101	Dom.	Sm.	Orth.	*Becquerelite*	Ox.	X=*c*. Y=*a*. Yellow: Y<Z	60
No cleav.	Ps. Hex.	Lg.	Orth.	*Caracolite*	Sul.	110 twin.	120
Z⊥001 ?	?	?	?	*Vilatéite*	Phos.	X=violet, Z=blue. G.=2.75	140
1̄01 dist.	Prism.	5°±	Mon.	*Allactite*	Arsen.	X∧*c*=−50°. Z=*b*. Gr. to yel.	155
?	?	Mod.	Mon.	*Chevkinite*	Sil.	Brown: X<Y<Z. G.=4.5±	423

Y⊥010 cl.	Fib.	65°	Mon.	*Alamosite*	Sil.	G.=6.5. Sol. HNO_3	401
001 perf.	001	70°±	Mon.	**EPIDOTE**	Sil.	Y=*b*. Golden: X<Y. G.=3.3±	314
X∧*c*=35°	100	Lg.	Mon.	**Allanite**	Sil.	Brown: X<Y<Z. G.=4.1±	316
100 dist.	El. ‖ *b*	83°	Mon.	*Sarkinite*	Arsen.	Y=*b*. Red to yel. G.=4.2	135
Group 35a. Refringence positive and extreme: N_o or $N_m>2.00$. Optically +							
110, 100	Prism.	0°	Tet.	*Phosgenite*	Carb.	G.=6.1±. Sol. HNO_3	85
0001 perf.	Mass.	0°	Hex.	Zincite	ZnO	Red. G.=5.5±	41
Z=*c*	El. ‖ *c*	0°	Hex.	*Voltzite*	ZnS+	G.=3.7	28
0001 dist.	Prism.	0°	Hex.	*Kleinite*	Hal.	Yellow. G.=8	38
10$\bar{1}$0 dist.	Fib.	0°	Hex.	*Wurtzite*	ZnS	Yellow: X>Z. G.=4	20
10$\bar{1}$0 dist.	Prism.	0°	Hex.	*Greenockite*	CdS	Yellow. G.=4.8	21
Group 35b. Refringence positive and extreme: N_o or $N_m>2.00$. Optically −							
X⊥001 cl.	Ps. Is.	0°	Tet.	*Boléite*	Hal.	Gr.-blue. G.=5±	37
X⊥001 cl.	?	0°	Tet.	*Lorettoite*	Hal.	Yellow. G.=7.5	38
X⊥0001 cl.	Rhom.	0°	Rhom.	*Barysilite*	Sil.	G.=6.7. Sol. HNO_3	401
X=*c*	Acic.	0°	Hex.	*Bellite*	Arsen.	Red or yel.: X<Z. G.=5.5	119
One perf.	?	Var.	Mon.?	*Volborthite*	Van.	Green. G.=3.5	137
001 dist. ?	Prism.	Sm.	Tr.?	*Kleinite*	Hal.	Yellow. G.=7.9±	38
V. Birefringence strong: $N_g-N_p>0.0275<0.0365$							
Group 36. Refringence negative and distinct: N_o or $N_m<1.48$. Optically + or −							
X ‖ fib.	Fib.	0°±	?	*Mendozite*	Sul.	G.=1.7. Sign −	113
X⊥010 cl.	Fib.	46°	Orth.	*Goslarite*	Sul.	Y=*c*. G.=2. Sign −	104
010, 011	Prism.	52°	Orth.	Epsomite	Sul.	X=*b*. Y=*c*. G.=1.68. Sign −	103
Y∧*c*=13°	Fib.	52°	Mon.?	Kalinite	Sul.	Z=*b*. G.=1.75. Sign −	113
100, 001	El. ‖ *b*	90°±	Mon.	*Kernite*	Bor.	Z=*b*. G.=1.95. Sign −?	90
Group 37a. Refringence negative and low: N_o or $N_m>1.48<1.54$. Optically +							
Y∧*c*=23°	Fib.	Mod.	Mon.	Ulexite	Bor.	Z=*b*. Cottony.	93
X⊥010 cl.	Acic.	70°±	Mon.	*Bobierrite*	Phos.	Z∧*c*=30°±. G.=2.4.	125
Y∧*c*=10°	Fib.	79°	Mon.	*Bischofite*	Hal.	X=*b*. G.=1.6.	32

TABLE II.—BIREFRINGENCE OF MINERALS

V. BIREFRINGENCE STRONG: $N_g - N_p > 0.0275 < 0.0365$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
				Group 37b. Refringence negative and low: N_o or $N_m > 1.48 < 1.54$. Optically −			
X = c	Pyr.	0°	Tet.	*Mellite*	Mel.	G. = 1.6. Sol. HNO_3.	88
X = c	Acic.	0°	Hex.	*Thaumasite*	Sul.	G. = 1.87. Sol. HCl.	119
$10\bar{1}0$ perf.	Prism.	0°	Hex.	Cancrinite	Sil.	G. = 2.5. Gel. HCl.	301
X ⊥ 0001 cl.	0001	0°	Hex.	*Brugnatellite*	Carb.	Pink. G. = 2 ±.	87
X ⊥ 001 cl.	001	69°	Orth.	*Uranospathite*	Phos.	Y = b. Yel.: X < Y, Z.	146
110 poor	Var.	56°	Tr.	Chalcanthite	Sul.	Bluish. G. = 2.2.	106
				Group 38a. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically +			
110 perf.	001	0°	Tet.	*Narsarsukite*	Sil.	Colorless or yel., X < Z. G. = 2.8	429
X = a. Y = b	Prism.	55° ±	Orth.	*Metavariscite*	Phos.	X = colorless; Y, Z = gr.	141
X ‖ fib.	Fib.	Lg.	?	*Tengerite*	Carb.	Sol. HCl	86
X ⊥ 001 cl.	001	25° ±	Mon.	*Cookeite*	Sil.	G. = 2.7	435
Z ⊥ 010 cl.	Prism.	41°	Mon.	*Botryogen*	Sul.	X = yel., Y = red, Z = orange	116
X ⊥ 010	010	60°	Mon.	*Hoernesite*	Arsen.	$Z \wedge c = 31°$. G. = 2.6	125
X = c	Y = b	Lg.	?	*Catapleite*	Sil.	G. = 2.66. Also monoclinic	400
				Group 38b. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically −			
				A. No visible cleavage			
X = c	Pyr.	0°	Tet.	*Mellite*	Mel.	G. = 1.6. Sol. HNO_3	88
100 dist.	Prism.	0°	Tet.	Mizzonite	Sil.	G. = 2.7 ±. Dec. HCl	297
110 poor	Var.	56°	Tr.	Chalcanthite	Sul.	Bluish. G. = 2.2	106
				B. One visible cleavage			
0001 perf.	0001	0°	Hex.	*Brugnatellite*	Carb.	Pink. G. = 2 ±	87
0001 perf.	0001	0°	Hex.	*Connarite*	Sil.	Green. G. = 2.5	280

0001	0001	0°	Hex.?	*Parsettensite*	Sil.	Yellow: X>Y>Z. G.=2.7	407
X⊥001 cl.	001	Sm.	?	**Talc**	Sil.	G.=2.75. Sol. HF	262
X⊥001 cl.±	Ps. Hex.	0°±	Mon.	*Nepouite*	Sil.	G.=3.1±. Sol. HCl	279
X⊥001 cl.±	Ps. Hex.	0°±	Mon.	**BIOTITE**	Sil.	Y=*b*. Br. or gr.: X<Y =Z	272
X⊥001 cl.±	Ps. Hex.	Sm.	Mon.	**Phlogopite**	Sil.	Y=*b*. Colorless or br.: X<Z	272
X⊥001 cl.±	Ps. Hex	25°±	Mon.	**Zinnwaldite**	Sil.	Z=*b*. Brown: X<Y=Z	270
X⊥001 cl.±	Ps. Hex	30°±	Mon.	**Lepidolite**	Sil.	Z=*b*. Colorless, pink, violet	270
X⊥001 cl.±	Ps. Hex	45°±	Mon.	**MUSCOVITE**	Sil.	Z=*b*. G.=2.8. Sol. HF	267
X⊥001 cl.±	Ps. Hex	Mod.	Mon.	Leverrierite	Sil.	Y=*b*. G.=2.5–2.6	433

Group 39a. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +

A. No visible cleavage

010 dist.	Pyr.	41°	Orth.	*Reddingite*	Phos.	X=colorless, Y=br., Z=yel.	124
‖ ext.	?	58°	Orth.	*Cebollite*	Sil.	G.=2.96. Alter. of melilite	431
Z⊥001 cl.	001	67°±	Orth.	Prehnite	Sil.	Y=*b*. G.=2.9. Lam. twin.	430
Z=*c*	El. ‖ *c*	Lg.	Orth.	*Barrandite*	Phos.	Tinted±. G.=2.6±	140
010, 001	Var.	85°	Orth.	**Forsterite**	Sil.	X=*b*. Y=*c*. G.=3.2	188
X∧*c*=28°	010	75°±	Mon.	Chondrodite	Sil.	Z=*b*. Colorless or yel.-gr.	196

B. One or more visible cleavage directions

Z⊥001 cl.	001	0°±	?	*Churchite*	Phos.	G.=3.1. Sol. HCl	156
110, 010	Ps. Hex.	25°±	Mon.	*Catapleite*	Sil.	Y=*b*. Z=*c*±. G.=2.75	400
X⊥010 cl.	Prism.	55°	Mon.	*Colemanite*	Bor.	Z∧*c*=83°. G.=2.4	93
110 at 55°	Fib.	85°±	Mon.	Cummingtonite	Sil.	Y=*b*. Z∧*c*=17°±. Yel.: **X, Y<Z**	243
100, 001	El. ‖ *b*	48°	Tr.	*Schizolite*	Sil.	Y∧*a*=9°. Z∧*b*=Sm. G.=3±	420
One cl.	100	Mod.	Tr.	*Messelite*	Phos.	Ext. on 100 at 20° from *c*.	128

Group 39b. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically −

A. No visible cleavage

100 dist.	Prism.	0°	Tet.	Mizzonite	Sil.	G.=2.7±	297
Y⊥100 cl.	Prism.	40°	Orth.	*Eosphorite*	Phos.	X=*b*. X=yel., Y=pink, Z=colorless	156

TABLE II.—BIREFRINGENCE OF MINERALS

V. Birefringence strong: $N_g - N_p > 0.0275 < 0.0365$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 39b. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically −, *continued*							
A. No visible cleavage—*continued*							
$Z = c$	Pyr.	55°±	Orth.	*Variscite*	Phos.	G. = 2.54. Also fibrous	140
$X \wedge c = -10°$	Pyr.	69°	Mon.	Lazulite	Phos.	$Y = b$. X = colorless; Y, Z = blue	154
$Z \wedge c = -3°$	Dom.	74°	Mon.	*Herderite*	Phos.	$Y = b$. G. = 3.0. Sol. HCl	134
X⊥010 cl.	Mass.	82°	Mon.	*Tilasite*	Arsen.	$Z \wedge c = -30°$. G. = 3.8	134
B. One or more visible cleavage directions and colorless							
X⊥0001 cl.	0001	0°	Hex.	*Friedelite*	Sil.	G. = 3.1. Gel. HCl	408
110, 010 perf.	?	Lg.	Orth.	*Catapleite*	Sil.	$X = c$. $Y = b$. G. = 2.66	400
X⊥001 cl.	001	Sm.	?	**Talc**	Sil.	$Z = b$. G. = 2.75	262
X⊥001 cl.±	Ps. Hex.	25°±	Mon.	*Kryptotile*	Sil.	$Y = b$. G. = 2.5±. Sol. H_2SO_4	421
X⊥001 cl.±	Ps. Hex.	25°±	Mon.	Leverrierite	Sil.	$Y = b$. Colorless or brown	433
X⊥001 cl.±	Prism.	25°	Mon.	*Ganophyllite*	Sil.	$Z = b$. X = yel., Y, Z = colorless	436
X⊥001 cl.±	Ps. Hex.	45°±	Mon.	**MUSCOVITE**	Sil.	$Z = b$. G. = 2.8. Sol. HF	267
X⊥010 cl.±	Prism.	60°	Tr.	*Inesite*	Sil.	G. = 3. Sol. HCl	413
C. One or more visible cleavage directions and colored							
X⊥001 cl.	001	0°±	?	*Bementite*	Sil.	Yel.; $X < Y = Z$	409
X⊥001 cl.±	Ps. Hex.	0°±	Mon.	*Nepouite*	Sil.	$Y = b$. X = gr.; Y, Z = gr.-yel.	279
X⊥001 cl.±	Ps. Hex.	0°±	Mon.	*Connarite*	Sil.	Yel.−gr. G. = 2.5	280
X⊥001 cl.±	Ps. Hex.	25°±	Mon.	Leverrierite	Sil.	$Y = b$. Colorless or brown	433
X⊥001 cl.±	Ps. Hex.	25°±	Mon.	**Zinnwaldite**	Sil.	$Z = b$. X = colorless; Y, Z = br.	270
X⊥001 cl.±	Prism.	25°±	Mon.	*Ganophyllite*	Sil.	$Z = b$. X = yel.; Y, Z = colorless	436
X⊥001 cl.±	001	Var.	Mon.?	*Nontronite*	Sil.	Br. or gr.; pleo. G. = 2.5	415

Group 40a. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +

A. No visible cleavage

0001, $11\bar{2}0$	Prism.	0°	Hex.	Willemite	Sil.	G.=4±. Sol. HCl	186
Z ∥ 110 cl.	?	71°	Orth.	*Manganandalusite*	Sil.	X=yellow, Y=green, Z=yellow	202
X⊥010 cl.	Var.	90°±	Orth.	**CHRYSOLITE**	Sil.	Y=*c*. G.=3.3. Gel. HCl	189
X⊥010 cl.	Fib.	90°±	Orth.	*Liskeardite*	Arsen.	Z=*c*. G.=3.0	142
X∧*a*=7°	Var.	62°	Mon.	*Titanclinohumite*	Sil.	Z=*b*. X=reddish; Y, Z=orange	198
X∧*c*=9°	Var.	76°	Mon.	Clinohumite	Sil.	Z=*b*. Colorless or yellowish	197
010 dist.	Prism.	69°	Tr.	*Spodiosite*	Phos.	Ext. on 010 at 38°	135

B. One visible cleavage

Z⊥001 cl.	Pyr.	20°±	Orth.	*Strengite*	Phos.	Colorless or pink; X, Y<Z	140
Y⊥100 cl.±	Prism.	28°	Mon.	*Molengraafite*	Sil.	X=*b*. Yellow: Y<X<Z	418
001 perf.	Prism.	60°	Mon.	*Rosenbuschite*	Sil.	X=*b*. Z∧*c*=−13°. Yel.: X<Y<Z	419
Y⊥010 cl.	Prism.	62°	Mon.	*Phosphosiderite*	Phos.	X∧*a*=4°. Colorless or pink: X>Y>Z	142
001 perf.	001	70°±	Mon.	*Piedmontite*	Sil.	X∧*c*=−7°. Y=*b*. Yel. to red	315

C. Two or more visible cleavage directions

110 at 87°	Prism.	60°	Mon.	**DIOPSIDE**	Sil.	Y=*b*. Z∧*c*=40°±. G.=3.3	224
110 at 87°	Prism.	60°	Mon.	Aegirinaugite	Sil.	Y=*b*. Z∧*c*=70°±. Yel. to gr.	232
110 at 87°	Prism.	62°±	Tr.	Babingtonite	Sil.	X=gr., Y=br., Z=br. or gr.	428

Group 40b. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically −

A. No visible cleavage

X=*c*	Prism.	0°	Rhom.	**Tourmaline (Fe)**	Sil.	Max. absorp. ⊥ elong.	301
Y=*b*. Z=*c*	Prism.	?	Orth.	*Soddite*	Ox.	Yellow. G.=4.6	61
Y⊥100 cl.	Prism.	40°	Orth.	*Eosphorite*	Phos.	X=*b*. X=yel., Y=pink, Z=white	156
X⊥010 cl.	Fib.	60°	Orth.	*Liskeardite*	Arsen.	Z=*c*. G.=3.0	142
X⊥100	100	65°	Orth.	*Erythrosiderite*	Hal.	X, Z=br., Y=red-yel. G.=2.3	35
X⊥010 cl.	100	85°±	Orth.	**Forsterite**	Sil.	Y=*c*. G.=3.2. Gel. HCl	188
Y⊥001 cl.	100	85°±	Orth.	*Picrotephroite*	Sil.	X=*b*. Gel. HCl	194

TABLE II.—BIREFRINGENCE OF MINERALS

V. BIREFRINGENCE STRONG: $N_g - N_p > 0.0275 < 0.0365$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
				Group 40b. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically −, *continued*			
				B. One or more visible cleavage directions			
0001 perf.	0001	0°	Hex.	*Friedelite*	Sil.	White or pink. G. = 3.1	408
0001 perf.	0001	0°	Hex.	*Pyrosmalite*	Sil.	Tinted ±. G. = 3.1	408
0001 perf.	0001	0°	Hex.	*Palmierite*	Sul.	G. = 4.5. Sol. HNO_3	110
X⊥001 cl.	001	36°	Orth.	*Tyrolite*	Arsen.	X = *c*. Y = *b*. Green: X, Z > Y	161
X⊥lam.	Lam.	Lg.	Orth.	*Trichalcite*	Arsen.	Y ‖ elong. Bl.-green	124
X⊥cleav.	?	Lg.	Orth.	*Sicklerite*	Phos.	Yellow: X > Y > Z. G. = 3.45	158
X⊥010	Ps. Tet.	0° ±	Mon.?	*Phosphuranylite*	Phos.	Yellow: X < Y, Z. Sol. HCl	147
Z⊥001 cl. ±	Pyr.	Mod.	Mon.	*Hodgkinsonite*	Sil.	Y = *b*. Pink or br. G. = 3.9	412
X⊥010 cl.	010	50°	Mon.	*Schroeckingerite*	Carb.	Z∧*c* − 41°. Yel.: X < Y, Z	86
110 at 56°	Prism.	Lg.	Mon.	**OXYHORNBLENDE**	Sil.	Y = *b*. Z∧*c* = 1°–10°. G. = 3.4. X = yel. Y, Z = br. or gr.	252
X⊥010 cl.	?	82°	Mon.	*Tilasite*	Arsen.	Z∧*c* = 30°. G. = 3.8	134
				Group 41a. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +			
0001, 10$\bar{1}$0	Prism.	0°	Hex.	*Ganomalite*	Sil.	G. = 5.6. Gel. HCl	407
Z ‖ fib.	Fib.	?	?	*Cervantite*	Ox.	G. = 4. Sol. HCl. Sign?	67
110	Acic.	?	Orth.	*Carminite*	Arsen.	Red. G. = 4.1. Sol. HNO_3	154
?	Gran.	26°	?	*Törnebohmite*	Sil.	X = yel., Y = gr., Z = pink. G. = 4.9	414
110, 010	?	41°	Orth.	*Caryinite*	Arsen.	X = *c*. Y = *a*. Brown	122
X = *b*. Y = *a*	Pyr.	50°	Orth.	*Lossenite*	Sul. +	Red. Sol. HCl	120
X = *b*. Y = *a*	Var.	65° ±	Orth.	Scorodite	Arsen.	Colorless or X = gr., Z = pink. Gr. = 3.2 ±	139
Y⊥100 cl. ±	Prism.	28°	Mon.	*Molengraafite*	Sil.	X = *b*. Yel.: X, Z > Y	418
Z∧*c* = 10°	Prism.	85°	Mon.	*Gadolinite*	Sil.	Y = *b*. Gr. or br.	424
No cleav.	Eq.	90° ±	Mon.	*Barthite*	Arsen.	Colorless or green. G. = 4.2	160

Group 41b. Refringence positive and very high: N_o or $N_m>1.74<2.00$. Optically −

0001 perf.	0001	0°	Rhom.	*Nordenskioeldite*	Bor.	Yellow. G.=4.2	95
Z⊥001 cl.	Prism.	Sm.	Orth.	Ilvaite	Sil.	X =yel., br., Y=br., Z=gr.	431
X⊥010 cl.	Var.	Lg.	Orth.	*Tephroite*	Sil.	Y=*c*. G.=4. Gel. HCl	194
X⊥001 cl.	Mass.	Lg.	Orth.	*Heterosite*	Phos.	X= br., Y=red, Z=violet	141
X⊥001 cl.±	Ps. Hex.	0°±	Mon.	Cronstedtite	Sil.	Y=*b*. X=br. or gr. Y, Z=opaque	285
X⊥010 cl.	Prism.	Sm.	Mon.	*Melanovanadite*	Van.	Br.: X<Y, Z. G.=3.5	102
001 perf.	001	70°±	Mon.	**EPIDOTE**	Sil.	Y=*b*. Golden: X<Y. G.=3.3±	314
X⊥cleav.	El. ‖ *b*	74°	Mon.	*Leucophenicite*	Sil.	G.=3.8. Sol. HCl	412
X∧*c*=20°	Prism.	80°	Mon.	*Laavenite*	Sil.	Y=*b*. Yellow: X, Y<Z	420
X⊥100 cl.±	Prism.	86°	Mon.	*Dietzeite*	Chr.	Y=*b*. Yellow. G.=3.7	121

Group 42. Refringence positive and extreme: N_o or $N_m>2.00$. Optically + or −

X⊥001 cl.	?	0°	Tet.	*Pseudobelêite*	Hal.	Deep blue. G.=4.85. Sign −	37
One	Fib.	?	?	*Cuprotungstite*	Tung.	Green. Sign ?	105
100 perf.	100	Sm.	Mon.	*Raspite*	Tung.	X∧*c*=Lg. Y=*b*. Yel.: X, Y<Z. Sign +	101

VI. Birefringence very strong: $N_g-N_p>0.0365<0.0545$

Group 43. Refringence negative and distinct: N_o or $N_m<1.48$. Optically + or −

Z=*c*	?	0°	?	*Paraffin*	C, H	G.=0.9. Sol. ether. Sign +	17
001 dist.	001	60°	Mon.	*Lansfordite*	Carb.	X=*b*. Z∧*c*=Sm. G.=1.73. Sign +	85

Group 44a. Refringence negative and low: N_o or $N_m>1.48<1.54$. Optically +

Z ‖ fib.	Fib.	Sm.	?	*Fibroferrite*	Sul.	Yellow: X, Y<Z. G.=1.86	109
X⊥100 cl.	?	40°	Orth.	*Uranothallite*	Carb.	Green. Sol. HCl	88
Y=*a*. Z=*c*	Pyr.	85°	Orth.	*Fluellite*	Hal.	G.=2.2	33
001 perf.	100	60°	Mon.	*Larderellite*	Bor.	X=*b*. Z∧*c*=+24°	91
100, 001	Var.	81°	Mon.	*Kaliborite*	Bor.	X=*b*. Z∧*c*=+65°. G.=2.1	94
100, 010	Fib.	Lg.	Mon.	*Hydroboracite*	Bor.	X∧*c*=31°. Y=*b*. G.=2.0	92
001 perf.	Ps. Mon.	39°	Tr.	*Ussingite*	Sil.	Z∧⊥001=33°±. G.=2.5	439

TABLE II.—BIREFRINGENCE OF MINERALS

VI. BIREFRINGENCE VERY STRONG: $N_g - N_p > 0.0365 < 0.0545$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 44b. Refringence negative and low: N_o or $N_m > 1.48 < 1.54$. Optically −							
$X = c$	Acic.	0°	Hex.	*Thaumasite*	Sul.	G. = 1.87	119
$X \perp 001$ cl.±	Ps. Hex.	Sm.	Mon.?	Leverrierite	Sil.	Colorless or br.: X < Y, Z	433
Group 45a. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically +							
Z ‖ fib.	Fib.	Sm.	?	*Fibroferrite*	Sul.	Yellow: X, Y < Z. G. = 1.86	109
001, 010	Var.	42°	Orth.	Anhydrite	Sul.	$Y = b$. $Z = a$. G. = 2.93	98
100, 001	Fib.	?	Mon.	*Magnesiopectolite*	Sil.	Z ‖ fib. G. = 2.7	420
100, 010	Fib.	Lg.	Mon.	*Hydroboracite*	Bor.	$X \wedge c = 31°$. $Y = b$. G. = 2.0	92
Group 45b. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically −							
$X \perp 001$ cl.±	001	Sm.	?	**Talc**	Sil.	$Z = b$. G. = 2.75±	262
$X \perp 001$ cl.±	001	56°±	?	Pyrophyllite	Sil.	G. = 2.85±	263
$X \perp 001$ cl.±	El. ‖ *a*	90°±	?	*Janosite*	Sul.	X = yel.-gr., Y = yel., Z = yel.	108
$X \perp 001$ cl.±	001	Sm.	Mon.	*Pholidolite*	Sil.	G. = 2.4. Greenish ±	435
100 perf.	El. ‖ *c*	Mod.	Mon.	*Jezekite*	Phos.	$X \wedge c = +29°$. $Y = b$. G. = 2.94	158
$X \perp 001$ cl.±	001	45°±	Mon.	**MUSCOVITE**	Sil.	$Z = b$. G. = 2.8±	267
Group 46a. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +							
A. No visible cleavage							
$Z = c$	Fib.	0°	Hex.?	*Rhabdophanite*	Phos.	G. = 4. Sol. HCl	139
$X = a$. $Z = b$	Tab.	68°	Orth.	Humite	Sil.	Colorless or yel.: X > Y, Z	197
$Z \wedge c = 36°$	?	38°	Mon.	*Arakawaite*	Phos.	$Y = b$. Green	138
$Z \perp 010$ cl.	El. ‖ *c*	77°	Mon.	*Leucosphenite*	Sil.	$Y \wedge c = 3°$. G = 3	418
?	Tab.	Sm.	Tr.?	*Destinezite*	Sul.	G. = 2.1. Sol. HCl	121
$1\bar{1}0$ + one	El. ‖ *c*	40°	Tr.	*Turquois*	Phos.	Ext. on $1\bar{1}0$ at 12° to *c*. Blue	157

				B. One or more visible cleavage directions			
10$\bar{1}$1 perf.	El. ‖ *c*	0°	Rhom.	*Dioptase*	Sil.	Green: X>Z. G.=3.2	186
X⊥010 cl.	010	58°	Orth.	*Haidingerite*	Arsen.	Z=*c*. G.=2.85	123
001 dist.	Ps. Hex.	0°±	Mon.?	*Pseudowollastonite*	Sil.	Z=*c*±. G.=2.9	402
100, 001	El. ‖ *b*	60°	Mon.	Pectolite	Sil.	X=*a*±. Z=*b*. G.=2.8±	419
010, 100	Prism.	80°	Mon.	Vivianite	Phos.	X=*b* Z∧*c*=+28°. G.=2.6. X=blue, Y=white, Z=olive	126
101, 010	Fib.	53°	Tr.	*Anapaite*	Phos.	Ext. on 100 at 15° to *c*.	128
				Group 46b. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically −			
				A. No visible cleavage			
X ‖ 100 cl.	Prism.	0°	Tet.	Meionite	Sil.	G.=2.75±. Dec. HCl	297
X=*c*	?	0°	Rhom.	*Chloraluminite*	Hal.	Sol. H_2O. Deliques.	33
Y⊥001 cl.	Prism.	Lg.	Orth.	*Sklodowskite*	Sil.	Yellow: X<Y<Z. G.=3.5	441
Z∧*c*=−2°	Prism.	74°	Mon.	Datolite	Sil.	Y=*b*. G.=2.9–3.0. Gel. HCl	424
				B. One or more visible cleavage directions			
001, 010	001	0°±	Tet.?	*Troegerite*	Arsen.	Yellow. G.=3.3. Sol. HCl	147
X⊥001 cl.	001	Sm.	?	**Talc**	Sil.	G.=2.75±. Sol. HF	262
X⊥100 cl.	El. ‖ *c*	30°	Orth.	*Grandidierite*	Sil.	Y=*c*. Green: Y<X<Z	421
X⊥001 cl.±	001	0°±	Mon.	*Nepouite*	Sil.	Y=*b*. X=gr.; Y, Z=yel.	279
X⊥001 cl.±	001	0°±	Mon.	**BIOTITE**	Sil.	Y=*b*. Br. or gr.: X<Y, Z	272
X⊥001 cl.±	001	Sm.	Mon.	Leverrierite	Sil.	Y=*b*. Colorless or br. X<Y, Z	433
X⊥001 cl.±	001	45°±	Mon.	**MUSCOVITE**	Sil.	Z=*b*. G.=2.8±	267
X⊥001 cl.±	001	Mod.	Mon.	*Fuchsite*	Sil.	Z=*b*. Colorless or gr.: X<Y, Z	269
				Group 47a. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +			
X=*b*. Y=*a*	Prism.	29°	Orth.	*Euchroite*	Arsen.	Green. G.=3.4. Sol. HNO_3	136
X⊥100 cl.	Tab.	75°±	Orth.	Iddingsite	Sil.	Z⊥001 cl. Br.: X<Y<Z	437
Y⊥010 cl.	Prism.	84°	Orth.	Diaspore	Ox.	Z=*a*. Colorless or br.: X>Z	46
101 dist.	El. ‖ *b*	88°±	Orth.	*Adamite*	Arsen.	X=*a*. Y=*c*. Colorless or pink	133
110 at 80°	Prism.	49°	Mon.	*Neptunite*	Sil.	Y=*b*. Z∧*c*=+18°. Br.: X<Y<Z	418
001 perf.	El. ‖ *b*	70°	Mon.	*Piedmontite*	Sil.	X∧*c*=−7°. Y=*b*. X=yel., Y=violet, Z=red	315

TABLE II.—BIREFRINGENCE OF MINERALS

VI. BIREFRINGENCE VERY STRONG: $N_g - N_p > 0.0365 < 0.0545$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 47a. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +, *continued*							
010 dist.	El. ǁ *c*	77°	Mon.	*Leucosphenite*	Sil.	$Y \wedge c = +3°$. $Z = b$. 001 twin.	418
001, 100	001	82°	Mon.	*Ludlamite*	Phos.	$Y = b$. $Z \wedge c = -67°$. Green	137
Group 47b. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically −							
A. No visible cleavage							
$X = c$	Prism.	0°	Rhom.	*Tourmaline (Cr)*	Sil.	X = yel., Z = gr. G. = 3.1	301
$X = b$. $Y = a$	Prism.	45°	Orth.	*Childrenite*	Phos.	G. = 3.2±. Sol. HCl	155
$X = b$. $Y = c$	Prism.	61°	Orth.	*Glaucochroite*	Sil.	G. = 3.4. Gel. HCl	187
X⊥010 cl.	Var.	Lg.	Orth.	*Tephroite*	Sil.	$Y = c$. G. = 4. Gel. HCl	194
$X = b$. $Y = c$	Prism.	85°±	Orth.	**CHRYSOLITE**	Sil.	G. = 3.3. Gel. HCl. (= **OLIVINE**)	189
101 dist.	El. ǁ *b*	88°	Orth.	*Adamite*	Arsen.	$X = a$. $Y = c$. Colorless or pink	133
001 dist.	?	40°	Mon.?	*Spurrite*	Sil.	$X = b$. $Z \wedge a = 0°\pm$. G. = 3±	442
110 at 70°	Pyr.	57°	Mon.	*Durangite*	Arsen.	$X \wedge c = -25°$. $Z = b$. Yel.: X > Y > Z	151
B. One or more visible cleavage directions							
X⊥0001 cl.	0001	0°±	Rhom.	*Pyrochroite*	Ox.	Reddish: X < Z	42
0001 perf.	0001	0°	Rhom.	*Spangolite*	Sul.	X = bl.-gr., Z = gr. G. = 3.1	119
X⊥100 cl.	Tab.	75°±	Orth.	Iddingsite	Sil.	Z⊥001 cl. Brown: X < Y < Z	437
X⊥001 cl.	Prism.	Lg.	Orth.	*Schoepite*	Ox.	Yellow: X < Y, Z. G. = 5.7	60
X⊥001 cl.±	001	0°±	Mon.	**BIOTITE**	Sil.	$Y = b$. X = yel., Y, Z = br. or gr.	272
X⊥010 cl.	010	50°±	Mon.	*Schroeckingerite*	Carb.	$Z \wedge c = 41°$. Yel.: X < Y, Z	86
110 at 56°	Prism.	80°±	Mon.	**OXYHORNBLENDE**	Sil.	$Y = b$. $Z \wedge c = 5°\pm$. G. = 3.4±. X = yel., Y = gr. or br. Z = br.±	252
110 at 56°	Prism.	82°±	Mon.	Grunerite	Sil.	Y = b. $Z \wedge c = 12°$. G. = 3.5±. X, Y = colorless, Z = yel., or gr.	242
001 perf.	Var.	50°	Tr.	*Tarbuttite*	Phos.	Ext. on 010 at 10° to *a*	135

Group 48a. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +

A. No visible cleavage

Z=*c*	Prism.	0°	Tet.	**Zircon**	Ox.	Colorless, br., gray. G.=4.7	183
Z=*c*	Pyr.	0°	Rhom.	*Benitoite*	Sil.	Tinted±: X<Z	212
Y ‖ fib.?	Fib.	Sm.	?	*Cornwallite*	Arsen.	Green. G.=4.1	136
X ‖ 120 cl.	Prism.	39°	Orth.	*Lorenzenite*	Sil.	Z=*b*. G.=3.4	400
Y ‖ 110 cl.	Prism.	67°	Orth.	*Orientite*	Sil.	X=*a*. Br. to yel.: X>Z>Y	432
Y or Z=*c*	Acic.	Lg.	Orth.	*Leucochalcite*	Arsen.	Silky white	136
Y=*c*. Z=*a*	001	Lg.	Orth.	*Flinkite*	Arsen.	X, Y=gr., Z=br. G.=3.87	154
X∧*c*=45°	Prism.	Sm.	Mon.	*Synadelphite*	Arsen.	Z=*b*. Br., nearly opaque	155
X∧*c*=89°	100	Mod.	Mon.	*Beraunite*	Phos.	Z=*b*. X, Y=pink, Z=red	144
Z∧*c*=45°	Fib.	Lg.	Mon.?	*Bayldonite*	Arsen.	X=*b*. Green. G.=4.35	137

B. One or more visible cleavage directions

X⊥001 cl.	?	38°	Orth.	*Purpurite*	Phos.	Y=*a*. X=gray, br., Y=red, Z=purple	141
Z⊥001 cl.	Lam.	45°±	Orth.	Iddingsite	Sil.	X=*a*. Red-br., X<Y<Z	437
Z⊥001 cl.±	El. ‖ *b*	16°	Mon.	Monazite	Phos.	X=*b*. Yellow: Y>X, Z	138
Z⊥010 cl.	Fib.	Sm.	Mon.	*Kraurite*	Phos.	X=*a*±. Br. or gr.: X<Y, Z	142
001 perf.	El. ‖ *b*	70°	Mon.	*Piedmontite*	Sil.	X∧*c*=7°. Y=b. G.=3.5. X=yel., Y=violet, pink, Z=red	315
110 at 87°	Prism.	Lg.?	Mon.?	*Jadite-acmite*	Sil.	Y=*b*. Z∧*c*=85°. G.=3.5	235

Group 48b. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically −

A. No visible cleavage

X=*c*	0001	0°	Hex.	Beaverite	Sul.	G.=4.36. Sol. HCl	115
X=*c*	Rhom.	0°	Rhom.	*Högbomite*	Ox.	X=yel., Z=br. G.=3.8	65
X⊥010 cl.	100	50°±	Orth.	**Fayalite**	Sil.	Y=*c*. Colorless or yellow	192
X⊥010 cl.	Var.	55°±	Orth.	*Knebelite*	Sil.	Y=*c*. Colorless or yellow	193
X⊥010 cl.	Var.	70°±	Orth.	**OLIVINE**	Sil.	Y=*c*. G.=4±. Gel. HCl	189
X=*a*. Y=*b*	Prism.	90°±	Orth.	*Higginsite*	Arsen.	X=gr., Y=yel.-gr., Z=bl.-green	132
X⊥010 cl.	?	50°±	Mon.	*Pascoite*	Sil.	X, Y=yel., Z=orange	160
110 dist.	Prism.	66°	Mon.	*Thortveitite*	Van.	X∧*c*=5°. Y=*b*. X=gr., Y, Z=yel.	211

TABLE II.—BIREFRINGENCE OF MINERALS

VI. BIREFRINGENCE VERY STRONG: $N_g - N_p > 0.0365 < 0.0545$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
				Group 48b. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically −, *continued*			
				B. One or more visible cleavage directions			
X⊥0001 cl.	0001	0°	Rhom.	*Molybdophyllite*	Sil.	G.=4.7	407
X⊥001 cl.	Lam.	Lg.	Orth.	*Heterosite*	Phos.	Y=*a*. X=gray, br., Y=red, Z=violet	141
X⊥010 cl.	Prism.	75°	Orth.	*Atacamite*	Hal.	Y=*a*. Green: X<Y<Z	38
X⊥010 cl.	Fib.	Sm.	Mon.	*Manganostibite*	Antim.	Z∧*c*=Lg. X=red-br., Z=opaque	155
001 perf.	001	50°	Mon.	*Hancockite*	Sil.	Y=*b*. X or Z=rose, Y=brown	316
110 at 88°	Prism.	60°±	Mon.	**Acmite**	Sil.	X∧*c*=5°±. Y=*b*. G.=3.5. Brown or green: X>Y>Z	234
001 perf.	001	70°±	Mon.	**EPIDOTE**	Sil.	X∧*c*=3°. Y=*b*. G.=3.5. Golden: X<Z<Y	314
100 perf.	El. ‖ *b*	80°	Mon.	*Linarite*	Sul.	X∧*c*=24°. Z=*b*. G.=5.4. Blue: X<Y<Z	104
				Group 49a. Refringence positive and extreme: N_o or $N_m > 2.00$. Optically +			
Z⊥0001 cl.	0001	0°	Rhom.	*Moissanite*	SiC	Tinted±: X>Z	17
X⊥001 cl.	100	50°±	Orth.	*Pseudobrookite*	Ox.	Z=*a*. Red-br.: X<Y>Z	165
001 poor	?	4°	Mon.	*Atelestite*	Arsen.	Yellow. G.=6.4	143
				Group 49b. Refringence positive and extreme: N_o or $N_m > 2.00$. Optically −			
X=*c*	Prism.	0°	Hex.	*Endlichite*	Van.	Yellow. G.=7	132
X=*c*	Var.	0°	Rhom.	*Langbanite*	Ox.	Brown: X<Z. G.=4.5	66
Z=*c*	Fib.	Mod.	?	*Bismutite*	Carb.	G.=7. Sol. HNO_3	86
				VII. BIREFRINGENCE EXTREME: $N_g - N_p > 0.0545$			
				Group 50. Refringence negative and distinct: N_o or $N_m < 1.48$. Optically + or −			
Z=*c*	Fib.	0°	?	Chrysocolla	Sil.	Green, etc.: X>Z. G.=2.4. Sign?	411
X⊥001 cl.±	001	7°	Tr.	*Sassolite*	Ox.	Ext. on 001 at 3°–20° to *a*. Sign −	50

Group 51a. Refringence negative and low: N_o or $N_m>1.48<1.54$. Optically +

Z⊥001 cl.?	001?	Sm.	Orth.	*Hatchettite*	C, H	Fibers have − elong.	18
Y=*c*. Z=*b*	Prism.	33°	Orth.	*Pirssonite*	Carb.	G.=2.35. Sol. HCl	87
X⊥100 cl.	Fib.	58°	Orth.	*Sideronatrite*	Sul.	Z ‖ fib. Yel.: X<Y, Z	115
X⊥001 cl.	001	60°±	Orth.	*Copiapite*	Sul.	Y=*b*. X=gr., Z=yel. G.=2.2	108
?	?	62°±	Orth.	*Bechilite*	Bor.	Doubtful species	92
X⊥001 cl.	001	66°	Orth.	*Knoxvillite*	Sul.	Y=*b*. Yellow-green: X, Y<Z	108
110 dist.	Prism.	34°	Mon.	*Quetenite*	Sul.	Orange: X, Y<Z. G.=2.1	116
$11\bar{1}$, $11\bar{3}$ perf.	Pyr.	57°	Mon.	Kieserite	Sul.	Y=*b*. $Z\wedge c=76°$. G.=2.57	104

Group 51b. Refringence negative and low: N_o or $N_m>1.48<1.54$. Optically −

011 perf.	Acic.	7°	Orth.	Niter	KNO_3	X=*c*. Y=*a*. G.=2.1	89
Y⊥laths	Lam.	61°	Orth.	*Nitroglauberite*	Nit.	Sol. H_2O	120
110 perf.	Acic.	77°	Orth.	*Dawsonite*	Carb.	X=*a*. Y=*c*. G.=2.4	87
Y=*c*	Fib.	Lg.	Orth.	*Artinite*	Carb.	G.=2.0. Sol. HCl	84
110?	Fib.	5°	Mon.	*Nitromagnesite*	Nit.	Sol. H_2O	89
100, 010 perf.	100	27°	Mon.	*Darapskite*	Sul.	X=*b*. $Z\wedge c=12°$. G.=2.2	120
110 perf.	El. ‖ *a*	34°	Mon.	*Gaylussite*	Carb.	X=*b*. $Z\wedge c=14°$. G.=1.9	87
100 perf.	El. ‖ *b*	72°	Mon.	*Trona*	Carb.	X=*b*. $Y\wedge c=7°$. G.=2.1	69
010 perf.	El. ‖ *c*	79°	Tr.	*Meyerhofferite*	Bor.	Z⊥010±. G.=2.1	93

Group 52a. Refringence positive and low: N_o or $N_m>1.54<1.59$. Optically +

Z=*c*	Fib.	0°	Hex.	*Cacoxenite*	Phos.	Yel. X<Z. G.=3.4	143
$10\bar{1}0$, 0001	Acic.	0°	Rhom.	*Ferrinatrite*	Sul.	G.=2.56. Sol. H_2O	114
X⊥001 cl.	001	Sm.	Orth.	*Rhomboclase*	Sul.	Y=*a*. X=red, Y, Z=yel., pink	108
X⊥001 cl.	001	60°±	Orth.	*Copiapite*	Sul.	Y=*b*. X=gr., Z=yel. G.=2.2	108
Z ‖ 110 cl.	Prism.	Lg.	Orth.	*Humboldtite*	Oxal.	Y=*b*. X=gr., Z=yel. "Oxalite"	88
010, 100	Prism.	87°	Orth.	*Hambergite*	Bor.	X=*a*. Y=*b*. G.=2.35	91
110 dist.	?	34°	Mon.	*Quetenite*	Sul.	Yel.: X, Y<Z. G.=2.1	116
$11\bar{1}$, $11\bar{3}$ perf.	Pyr.	57°	Mon.	Kieserite	Sul.	Y=*b*. $Z\wedge c=76°$. G.=2.57	104

TABLE II.—BIREFRINGENCE OF MINERALS

VII. BIREFRINGENCE EXTREME: $N_g - N_p > 0.0545$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
				Group 52a. Refringence positive and low: N_o or $N_m > 1.54 < 1.59$. Optically +, *continued*			
001, 010 +	Var.	84°	Mon.	*Whewellite*	Oxal.	X = *b*. Z∧*c* = 29°. G. = 2.2	89
001 perf.	El. ∥ *b*	87°	Mon.	*Fichtelite*	C, H	Z∧*c* = 13°. Sol. ether	18
				Group 52b. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically −			
10$\bar{1}$1 perf.	Rhom.	0°	Rhom.	*Nitratite*	$NaNO_3$	G. = 2.27. Deliques.	89
10$\bar{1}$1 poor	Rhom.	0°	Rhom.	*Trudellite*	Sul.	G. = 1.93. Deliques.	119
X⊥001 cl.	100	62°	Orth.	*Oxammite*	Oxal.	Y = *a*. G. = 1.5. Sol. H_2O	89
X⊥001 cl.	001	62°	Orth.	*Lanthanite*	Carb.	Y = *a*. G. = 2.7±. Sol. HCl	86
Y = *c*	Fib.	71°	Orth.	*Artinite*	Carb.	G. = 2.0. Sol. HCl	84
110 perf.	Acic.	77°	Orth.	*Dawsonite*	Carb.	X = *a*. Y = *c*. G. = 2.4	87
?	?	Lg.	?	*Cu-aphthitalite*	Sul.	G. = 3? Sol. H_2O	96
X⊥001 cl.±	001	Sm.	Mon.	*Griffithite*	Sil.	X = yel., Z = br.-gr.	434
010, 011 perf.	Prism.	79°	Mon.	*Kroehnkite*	Sul.	X∧*c* = 49°. Y = *b*. Sol. H_2O	112
?	001	51°	Tr.	*Roemerite*	Sul.	Ext. on 101 at 33° to *c*	117
010 perf.	El. ∥ *c*	79°	Tr.	*Meyerhofferite*	Bor.	Z⊥010±. G. = 2.1	93
				Group 53a. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +			
X⊥laths	Lath.	Sm.	Orth.	*Bisbeeite*	Sil.	Z = *c*. Colorless or X, Y = br., Z = gr.	411
Z ∥ fib.	Fib.	Mod.	Orth.	*Planchéite*	Sil.	X⊥cleav. Blue: X, Y<Z	411
X⊥laths	Lath.	83°	Orth.	*Kyanotrichite*	Sul.	Z = *c*. Blue: X, Y<Z	116
010, 100	Prism.	87°	Orth.	*Hambergite*	Bor.	X = *a*. Y = *b*. G. = 2.35	91
011 perf.	Pyr.	37°	Mon.	*Natrochalcite*	Sul.	Y = *b*. Z∧*c* = 12°. Green	112
Z∧*c* = 33°?	?	71°	Mon.?	*Veszelyite*	Phos.	Y = *b*? Gr.-blue. G. = 3.5	138
One perf.	?	90°±(art.)	Mon.	*Szmikite*	Sul.	Z = *b*. Pink±	104

Group 53b. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically −

				A. No visible cleavage			
$X = c$	Acic.	0°	?	*Szaibelyite*	Bor.	G. = 3. Sol. H_2SO_4	92
$Y \perp$ laths	Lath.	Lg.	Orth.	*Camsellite*	Bor.	$X \parallel$ elong.	91
$Z \wedge c = 25°$	?	67°	Mon.	*Liroconite*	Arsen.	$X = b$. Greenish. G. = 2.9	157
010 dist.	Fib.	Lg.	Tr.	*Stewartite*	Phos.	$X \perp 100 \pm$. Yel.: $X < Y < Z$	128
				B. One or more visible cleavage directions			
$10\bar{1}1$ perf.	Var.	0°	Rhom.	**CALCITE**	$CaCO_3$	G. = 2.71. Sol. HCl	71
$X \perp 0001$ cl.	0001	0°	Rhom.	*Chalcophyllite*	Arsen.	Green. G. = 2.5	136
$X \perp 001$	001	35°	Orth.	*Serpierite*	Sul.	$Y = a$. X = gr., Y, Z = gr.-blue	102
$X \perp 001$ cl.±	001	0°±	Mon.	**BIOTITE**	Sil.	$Y = b$. Br. or gr.: $X < Y, Z$	272
$X \perp 001$ cl.±	001	0°±	Mon.	*Stilpnomelane*	Sil.	X = yel., Y, Z = brown	435
$X \perp 001$ cl.±	001	0°±	Mon.	*Ekmannite*	Sil.	Greenish: $X < Y = Z$	281
$X \perp 001$ cl.±	001	39°	Mon.	*Herrengrundite*	Sul.	$Z = b$. Green: $X < Y, Z$. G. = 3.1	104
001 perf.	001	80°	Mon.	*Epistolite*	Sil.	$Y = b$. $Z \wedge c = 7°$. G. = 2.9	442
$X \perp 010$ cl.	Fib.	84°	Mon.	*Annabergite*	Arsen.	$Z \wedge c = 36°$. Green±	127
$X \perp 010$ cl.	Fib.	90°±	Mon.	*Cabrerite*	Arsen.	$Z \wedge c = 33°$. Green±	127
100, 010 perf.	Prism.	28°±	Tr.	*Amarantite*	Sul.	$X \perp 100 \pm$. Yel.: $X < Y < Z$	109

Group 54a. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +

110 perf.	Prism.	0°	Tet.	Xenotime	YPO_4	Colorless or X = pink, Z = brown	138
0001 perf.	Prism.	0°	Hex.	*Parisite*	Carb.	Yel.: $X < Z$. G. = 4.4	85
0001 part.	Prism.	0°	Hex.	*Bastnäsite*	Carb.	Yellow. G. = 5	85
$Z = c$	Acic.	0°±	?	*Mixite*	Arsen.	Green. G. = 3.8	156
$Z \perp 001$ cl.	Fib.	28°±	Orth.	*Ferrimolybdite*	Molyb.	$Y = a$. Yel.: $X, Y < Z$. G. = 4.5	108
$X \perp 010$ cl.	Dom.	35°	Orth.	*Antlerite*	Sul.	$Y = c$. Green: $Y > Z > X$	102
$X \perp$ cleav.	Fib.	Mod.	Orth.	*Planchéite*	Sil.	$Z = c$. Blue: $X, Y < Z$	411
$X \perp 010$ cl.	Prism.	75°	Orth.	*Astrophyllite*	Sil.	$Z = a$. Yellow: $X > Y > Z$	417
$Z \perp 001$ cl.	?	84°	Orth.	*Curtisite*	C, H, O	$Y = b$. Yellow: $X < Y < Z$	18
$Y \perp 010$ cl.	Fib.	73°	Mon.?	*Lindackerite*	Sul.	$X \wedge c = 26°$. Green	121
$X \perp 010$ cl.	Fib.	77°	Mon.	*Koettigite*	Arsen.	$Z \wedge c = 37°$. Carmine	127
$X \perp 010$ cl.	Prism.	89°	Mon.	Erythrite	Arsen.	$Z \wedge c = 32°$. X = pink, Y = violet, Z = red	127

TABLE II.—BIREFRINGENCE OF MINERALS

VII. Birefringence extreme: $N_g - N_p > 0.0545$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 54b. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically —							
A. No visible cleavage							
$X=c$	0001	0°	Hex.	*Chloromagnesite*	Hal.	Sol. H_2O. Deliques.	32
010, 110	Acic.	7°	Orth.	*Alstonite*	Carb.	$X=c$. $Y=b$. G.=3.7. Sol. HCl	80
110 dist.	Acic.	11°	Orth.	Strontianite	Carb.	$X=c$. $Y=b$. G.=3.7. Sol. HCl	81
010 dist.	Pyr.	16°	Orth.	Witherite	Carb.	$X=c$. $Y=b$. G.=4.3. Sol. HCl	81
010, 110	Acic.	18°	Orth.	**Aragonite**	Carb.	$X=c$. $Y=a$. G.=2.94. Sol. HCl	79
$X=c$	Fib.	Sm.	Orth.	*Sussexite*	Bor.	G.=3.12. Sol. HCl	91
$X=a$. $Y=b$?	Pyr.	66°	Orth.	*Ancylite*	Carb.	Green. G.=3.95. Sol. HCl	87
$X\perp$010 cl.	010	Lg.	Mon.	*Zippeite*	Sul.	$Z\wedge c=35°\pm$. Yel.: $X<Y<Z$	110
010 dist.	100	Lg.	Tr.	*Stewartite*	Phos.	$X=a\pm$. Yel.: $X<Y<Z$. G.=2.9	128
B. One visible cleavage							
$X\perp$001 cl.±	001	0°±	Mon.	**BIOTITE**	Sil.	$Y=b$. Br. or gr.: $X<Y, Z$	272
$X\perp$001 cl.±	001	0°±	Mon.	*Ekmannite*	Sil.	Gr.-brown: $X<Y=Z$	281
$Y\perp$100 cl.±	100	Sm.	Mon.	*Aurichalcite*	Carb.	$Z\wedge c$=Sm. Green: $X<Y, Z$	84
$X\perp$001 cl.±	001	Sm.	Mon.	*Stilpnomelane*	Sil.	X=yel., Y, Z=gr. or br.	435
$X\perp$001 cl.±	001	35°±	Mon.	*Roscoelite*	Sil.	$Z=b$. X, Y=olive, Z=gr.-br.	270
100 perf.	100	40°	Mon.	*Hydrozincite*	Carb.	$X=b$. $Z\wedge c$=Mod. G.=3.6	83
$X\perp$010 cl.	Prism.	87°	Mon.	*Symplesite*	Arsen.	$Z\wedge c=32°$. Yel., gr., bl.; pleo.	126
C. Two or more visible cleavage directions							
$10\bar{1}1$ perf.	Var.	0°	Rhom.	*Manganocalcite*	Carb.	G.=2.9±. Sol. HCl	72
$10\bar{1}1$ perf.	Var.	0°	Rhom.	*Plumbocalcite*	Carb.	G.=2.72+. Sol. HCl	72
$10\bar{1}1$ perf.	Rhom.	0°	Rhom.	**MG-DOLOMITE**	Carb.	G.=2.9+. Sol. HCl	73
$10\bar{1}1$ perf.	Rhom.	0°	Rhom.	Mangandolomite	Carb.	G.=3.3±. Sol. HCl	73

$10\bar{1}1$ perf.	Rhom.	0°	Rhom.	Ankerite	Carb.	G.=3±. Sol. HCl	73
$10\bar{1}1$ perf.	Rhom.	0°	Rhom.	*Breunnerite*	Carb.	G.=3±. Sol. HCl	75
$10\bar{1}1$ perf.	Rhom.	0°	Rhom.	Magnesite	Carb.	G.=3±. Sol. HCl	75
$10\bar{1}1$ perf.	Rhom.	0°	Rhom.	*Mesitite*	Carb.	G.=3.2±. Sol. HCl	75
110 perf.	Var.	14°	Mon.	*Barytocalcite*	Carb.	$X \wedge c=64^\circ$. $Z=b$. G.=3.6	82
110 at 56°	Prism.	80°±	Mon.	**OXYHORNBLENDE**	Sil.	$Y=b$. $Z \wedge c=5^\circ$±. Br. or gr. $X<Y, Z$	252

Group 55a. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +

A. No visible cleavage and not elongated or with negative elongation

100 dist.	001	0°	Tet.	*Calomel*	Hg_2Cl_2	Also pyr. G.=6.5	30
$Z=c$	0001	0°	Hex.	*Vegasite*	Sul.	Yellow: $X<Z$	116
100, 001	Prism.	Sm.	Orth.	*Hoelite*	C, H, O	$X=c$. $Y=a$. G.=1.4	18
110 dist.	Wedge	30°±	Mon.	**Titanite**	Sil.	$Y=b$. $Z \wedge c=51^\circ$. Colorless or pleo.	204
110 dist.	Wedge	50°±	Mon.	*Keilhauite*	Sil.	$Y=b$. $Z \wedge c=51^\circ$. Brown; pleo.	205
011 dist.	Prism.	90°±	Mon.	*Lautarite*	Iod.	$X \wedge c=25^\circ$. $Y=b$. G.=4.6	89

B. No visible cleavage and positive elongation

$Z=c$	Prism.	0°	Tet.	**Zircon**	$ZrSiO_4$	Colorless or tinted. G.=4.7	183
$Z \parallel$ 110 cl.	Prism.	0°	Tet.	Cassiterite	SnO_2	Colorless or br., etc. G.=7	52
$Z=c$	Prism.	Sm.	Orth.	*Ludwigite*	Bor.	X, Y=gr., Z=br. G.=4	94
$Z=c$	Acic.	Sm.	Orth.	*Mixite*	Arsen.	Green. G.=3.8	156
$Z \perp$ 001 cl.	Fib.	28°	Orth.	*Ferrimolybdite*	Molyb.	$X=b$. Yel.: $X, Y<Z$. G.=4.5	108
$X \perp$ 010 cl.	Prism.	35°	Orth.	*Hemafibrite*	Arsen.	$Y=a$. Red-br. G.=3.6	136
$X \perp$ 100	100	Mod.	Orth.	*Uraconite*	Sul.	$Y=b$. Yellow. Sol. HCl	110
$X \perp$ 100	100	82°	Orth.	*Olivenite*	Arsen.	$Y=c$. Olive: $X, Y<Z$. G.=4	132
$X \perp$ 010	010	58°	Mon.	*Schultenite*	Arsen.	$Z \wedge c=+66^\circ$. G.=5.94	123
$Z \wedge c$=Sm.	Fib.	Lg.	Mon.	*Shattuckite*	Sil.	$X=b$. Blue: $X<Y<Z$. G.=3.8	411
$X \wedge c=22^\circ$	El. $\parallel b$	90°±	Tr.?	*Dihydrite*	Phos.	$Z=b$±. X=bl., Y=gr., Z=br.	135

C. One or more visible cleavage directions

100 perf.	Pyr.	0°	Tet.	*Trippkeite*	Arsen.	Bl.-green. Sol. HCl	159
$X \perp$ 001 cl.	?	38°	Orth.	*Purpurite*	Phos.	$Y=a$. X=gray; Y, Z=red	141

TABLE II.—BIREFRINGENCE OF MINERALS

VII. BIREFRINGENCE EXTREME: $N_g - N_p > 0.0545$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 55a. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +, *continued*							
C. One or more visible cleavage directions—*continued*							
Z ‖ fib.	Fib.	40°	Orth.	*Taramellite*	Sil.	X, Y = red; Z = br. G. = 3.9	427
Two pinac.	?	52°	Orth.	*Uvanite*	Van.	Brown: Y > X > Z	148
X ⊥ 100 cl.	Fib.	Lg.	Orth.	*Uranospherite*	Uran.	X = *b*. Yellow. G. = 6.36	109
Y ⊥ 010 cl.	Prism.	58°	Mon.	*Claudétite*	As_2O_3	$Z \wedge c = 6°$. G. = 4 ±	45
021 perf.	Var.	68°	Mon.	Azurite	Carb.	X = *b*. $Z \wedge c = 12°$. Blue: X < Y < Z	82
001 perf.	001	70° ±	Mon.	*Piedmontite*	Sil.	$X \wedge c = 7°$. Y = *b*. X = yel., Z = red	315
Z ⊥ 010 cl.	Fib.	90°	Mon.?	*Dufrenite*	Phos.	X = *c* ±. X = br., Y = yel., Z = gr.	142
Group 55b. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically −							
A. No visible cleavage and uniaxial							
X ⊥ 001 cl.	?	0°	Tet. ?	*Arseniosiderite*	Arsen.	X = yel., Z = brown. G. = 3.7 ±	153
X ⊥ 0001 cl.	Prism.	0°	Hex.	*Cordylite*	Carb.	X = br., Z = gr.-yel. G. = 4.3	86
X = *c*	Fib.	0°	Hex.	*Ferritungstite*	Tung.	Yellow. Dec. HCl	107
0001 dist.	0001	0°	Rhom.	*Carphosiderite*	Sul.	Yellow. G. = 2.6 ±	108
0001 dist.	0001	0°	Rhom.	*Jarosite*	Sul.	Yellow: X < Z. G. = 3.2	114
0001 dist.	0001	0°	Rhom.	*Natrojarosite*	Sul.	Yellow: X < Z. G. = 3.2	114
$10\bar{1}1$ dist.	0001	0°	Rhom.	*Plumbojarosite*	Sul.	X = golden, Z = red. G. = 3.6	115
X = *c*	Prism.	0° ±	?	*Mazapilite*	Arsen.	Brown: X < Z. G. = 3.6	156
B. No visible cleavage and biaxial							
Z ‖ elong.	Lath	?	Orth.	*Chapmanite*	Sil.	Olive green. G. = 3.6	440
X = *a*. Y = *c*	Dom.	33°	Orth.	*Cornetite*	Phos.	Green. G. = 4.1. Sol. HCl	132

$X = b$. $Y = c$	Eq.	83°	Orth.	*Libethenite*	Phos.	Green. X, Z<Y. G.=3.7	132
010 cleav.	Fib.	Sm.	Mon.	*Tagilite*	Phos.	X∧elong.=Sm. Green	137
Z ∥ elong.	Fib.	50°	Mon.	*Pseudomalachite*	Phos.	Green. G.=3.6	135
X⊥010 cl.±	010	24°	Tr.	*Chalcosiderite*	Phos.	Green: X<Z. G.=3.1	157
X⊥010±	010	52°	Tr.	*Walpurgite*	Arsen.	Yellow. G.=5.8	148
			C. One or two visible cleavage directions and uniaxial or 2V<40°				
X⊥001 cl.	001	0°	Tet.?	*Freirinite*	Arsen.	Gr.-blue: X<Z. Sol. HCl	151
X⊥001 cl.	Prism.	22°	Orth.	*Durdenite*	Tel.	$Y = b$. Yel.: X<Y<Z	118
Z⊥cleav.	?	Mod.	Orth.	*Erinite*	Arsen.	Y ∥ elong. Green. G.=4	133
X⊥001 cl.	001	40°	Orth.	*Carnotite*	Van.	$Y = a$. Yellow±	148
X⊥001 cl.±	001	0°±	Mon.	*Chalcodite*	Sil.	X=yel.; Y, Z=red-br. G.=3±	435
Z ∥ elong.	Lam.	Sm.	Mon.?	*Aurichalcite*	Carb.	$Y = a$±. Green. X<Y, Z	84
001 perf.	001	10°	Mon.	*Leadhillite*	Sul.	$X \wedge c = 5°$. $Z = b$. G.=6.4	120
			D. One or two visible cleavage directions and 2V>40°				
X⊥001 cl.	001	40°	Orth.	*Carnotite*	Van.	$Y = a$. Yellow±	148
X⊥001 cl.	001	45°±	Orth.	*Tyuyamunite*	Van.	$Y = b$. Yellow: X<Y<Z	147
X⊥010 cl.	Prism.	72°	Orth.	*Brochantite*	Sul.	$Y = a$. Green: X, Y<Z	102
X⊥001 cl.	El. ∥ *a*	81°	Orth.	*Langite*	Sul.	Y⊥010 cl. Green; pleo.	102
Z⊥001 cl.	El. ∥ *a*	85°	Orth.	*Caledonite*	Sul.	X⊥100 cl. Bl.-green; pleo.	120
001, 010	Fib.	43°	Mon.	Malachite	Carb.	$X \wedge c = 24°$. $Y = b$. Green: X<Y<Z	83
X⊥001 cl.±	El. ∥ *b*	47°	Mon.	*Lanarkite*	Sul.	$Y = b$. G.=6.6	102
X⊥001 cl.±	Prism.	53°	Mon.	*Clinoclasite*	Arsen.	$Y = b$. Green; Pleo. G.=4.3	135
110 at 87°	Prism.	60°±	Mon.	**Acmite**	Sil.	$X \wedge c = 5°$. $Y = b$. G.=3.5. Gr. or br.; pleo. Sol. HF	234
			E. Three visible cleavage directions				
$10\bar{1}1$ perf.	Rhom.	0°	Rhom.	Ankerite	Carb.	G.=3.0. Sol. HCl	73
$10\bar{1}1$ perf.	Rhom.	0°	Rhom.	*Ferrodolomite*	Carb.	G.=3.3. Sol. HCl	73
$10\bar{1}1$ perf.	Rhom.	0°	Rhom.	*Mangandolomite*	Carb.	G.=3.3. Sol. HCl	73

TABLE II.—BIREFRINGENCE OF MINERALS

VII. BIREFRINGENCE EXTREME: $N_g - N_p > 0.0545$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
				Group 55b. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically −, *continued*			
				E. Three visible cleavage directions—*continued*			
$10\bar{1}1$ perf.	Rhom.	0°	Rhom.	*Mesitite*	Carb.	G.=3.2. Sol. HCl	75
$10\bar{1}1$ perf.	Rhom.	0°	Rhom.	*Pistomesite*	Carb.	G.=3.5. Sol. HCl	75
$10\bar{1}1$ perf.	Rhom.	0°	Rhom.	*Sideroplesite*	Carb.	G.=3.8. Sol. HCl	75
$10\bar{1}1$ perf.	Rhom.	0°	Rhom.	**Siderite**	Carb.	Gray. G.=3.9. Sol. HCl	76
$01\bar{1}1$ perf.	Rhom.	0°	Rhom.	*Oligonite*	Carb.	G.=3.8. Sol. HCl	76
$10\bar{1}1$ perf.	Rhom.	0°	Rhom.	Rhodochrosite	Carb.	G.=3.7. Sol. HCl	77
$10\bar{1}1$ perf.	Rhom.	0°	Rhom.	*Spherocobaltite*	Carb.	G.=4.1. Sol. HCl	78
$10\bar{1}1$ perf.	Rhom.	0°	Rhom.	Smithsonite	Carb.	G.=4.3. Sol. HCl	78
010 + two	Lam.	83°	Tr.	*Margarosanite*	Sil.	$X' \wedge$ cleav. in 010=44°. G.=4.0	406
				Group 56a. Refringence positive and extreme: N_o or $N_m > 2.00$. Optically +			
				A. No visible cleavage and no elongation			
$Z=c$	Pyr.	0°	Tet.	*Tapiolite*	Tant.	X=br., Z=opaque	164
$Z=a$	Var.	Sm.	Orth.	*Brookite*	TiO_2	Yel.: X<Y<Z. Ext. Disp.	59
?	?	Sm.	?	*Tripuhyite*	Antim.	Gr.-yel. G.=5.8	160
?	?	Sm.	Orth.	*Hjelmite*	Tant.	X, Y=yel.-br.; Z=opaque	166
$Y=b$. $Z=c$	Pyr.	69°	Orth.	Sulfur	S	G.=2. Sol. CS_2	14
				B. No visible cleavage and prismatic or lamellar elongation			
110 dist.	Prism.	0°	Tet.	**Rutile**	TiO_2	Br.-red: X<Z. G.=4.3±	50
0001 dist.	Prism.	0°	Hex.	*Penfieldite*	Hal.	Sol. HNO_3. F=1	38
?	Prism.	Sm.	Orth.	*Derbylite*	Tit.	Brown. G.=4.5	162
Two cleav.	Prism.	67°	Orth.	*Melanotekite*	Sil.	Brown: X<Y<Z. G.=5.7	427

110 dist.	Prism.	88°	Orth.	*Kentrolite*	Sil.	Red-brown: X<Y<Z. G.=6.2	427
100 dist.	Prism.	Lg.	Orth.	*Tantalite*	Tant.	Red to opaque. G.=7.5±	165
110 at 86°	Prism.	57°	Mon.	*Crocoite*	Chrom.	Y=*b*. Z∧*c*=6°. Yellow	101
?	Prism.	Lg.	Mon.?	*Brackebuschite*	Van.	Brown: X<Y, Z	125
One cleav.	Lam.	83°	Mon.	*Calciovolborthite*	Van.	Green. Ext. Disp.	135
			C. One or more visible cleavage directions and lamellar elongation				
$10\bar{1}0$ perf.	0001	0°	Hex.	Cinnabar	HgS	Red. G.=8.2	21
One perf.	Tab.	Mod.	Orth.	*Phenicochroite*	Chrom.	Red. G.=5.75. Sol. HCl	100
001 perf.	010	67°	Orth.	*Cotunnite*	$PbCl_2$	Y=*b*. Z=*c*. G.=5.8	32
010, 001	010	83°	Orth.	*Lepidocrocite*	Ox.	Orange: X<Y<Z. G.=4.1	48
100 perf.	100	Lg.	Orth.	*Nadorite*	Antim.	Yellow. X=*a*. Y=*b*. G.=7	159
100 perf.	100	Lg.	Orth.	*Massicotite*	PbO	Yel.: X, Y<Z. G.=9.3	41
010 perf.	010	90°±	Orth.	*Tellurite*	TeO_2	X=*b*. Y=*a*. G.=5.9	59
X⊥010 cl.	010	24°	Mon.	Orpiment	As_2S_3	Z=*a*±. · Yellow. G.=3.4	25
			D. One or more visible cleavage directions and prismatic elongation				
010, 110	Prism.	Sm.	?	*Manganite*	Ox.	Y=*b*. Z=*c*. Brown: X<Z	48
X⊥100 cl.	Prism.	75°±	Orth.	*Stibiotantalite*	Tant.	Z=*c*. Brown±. G.=7.9	167
110, 100, 010	Fib.	Lg.	Orth.	*Mendipite*	Hal.	X=*a*. Z=*c*. G.=7	38
010 perf.	Prism.	Lg.	Orth.	*Montroydite*	HgO	Z=*c*. Yellow. Sol. HCl	41
100, 001	Prism.	?	Mon.	*Lorandite*	$TlAsS_2$	Red. G.=4.5. Sol. HNO_3	28
100, 101	Dom.	Sm.	Mon.?	*Kermesite*	Sb_2S_2O	Y or Z=*b*. Red: X>Y>Z	28
X⊥010 cl.	Prism.	73°	Mon.	Huebnerite	Tung.	Z∧*c*=18°. Br., gr.; pleo.	101
			56b. Refringence positive and extreme: N_o or $N_m > 2.00$. Optically −				
			A. No visible cleavage and uniaxial and not red				
101 dist.	?	0°	Tet.	*Cumengéite*	Hal.	Blue. G.=4.8±	37
X=*c*	Pyr.	0°	Tet.	*Stolzite*	Tung.	G.=8±. Dec. HNO_3	98
X=*c*	Prism.	0°	Tet.	*Plattnerite*	PbO_2	Brown. Also biax. G.=8.5	53
001 dist.	Pyr.	0°	Tet.	*Ecdemite*	Arsen.	Green. Also biax. G.=7±	159
111 dist.	001	0°	Tet.	Wulfenite	Molyb.	Colorless or yellow: X<Z. G.=6.9	98

TABLE II.—BIREFRINGENCE OF MINERALS

VII. BIREFRINGENCE EXTREME: $N_g - N_p > 0.0545$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 56b. Refringence positive and extreme: N_o or $N_m > 2.00$. Optically −, *continued*							
A. No visible cleavage and uniaxial and not red—*continued*							
001 dist.	Pyr.	0°	Tet.	*Hausmannite*	Ox.	Brown to opaque. G. = 4.8	64
001, 111	Pyr.	0°	Tet.	*Anatase*	TiO_2	Yel., bl.: X<Z. G. = 3.8±	53
X = *c*	?	0°	?	*Bindheimite*	Antim.	Gray, etc. G. = 4.8±	160
X = *c*	Fib.	0°	Hex.?	*Bismutospherite*	Carb.	Yellow, etc. G. = 7.4±	86
X = *c*	Prism.	0°	Hex.	Vanadinite	Van.	Colorless or yel. X<Z	131
B. No visible cleavage and uniaxial and red							
X = *c*	Rhom.	0°	Rhom.	**HEMATITE**	Fe_2O_3	Red to black. G. = 5.2	44
X = *c*	Fib.	0°	?	*Hydrohematite*	Ox.	Red. G. = 4.5–5. Sol. HCl	45
$10\bar{1}1$, 0001	Prism.	0°	Rhom.	*Trechmannite*	$AgAsS_2$	X = colorless, Z = red. Inverts	27
$10\bar{1}1$ dist.	Prism.	0°	Rhom.	Pyrargyrite	Ag_3SbS_3	Red. G. = 5.8	27
$10\bar{1}1$ dist.	Rhom.	0°	Rhom.	*Proustite*	Ag_3AsS_3	Red. G. = 5.6	27
C. No visible cleavage and biaxial with parallel extinction in axial zones							
110 at 90°±	Prism.	?	?	*Livingstonite*	$HgSb_4S_7$	Z = *c*. Red: X>Z. G. = 4.8	28
110, 021	010	9°	Orth.	Cerussite	Carb.	X = *c*. Y = *b*. G. = 6.57	80
X ⊥ 010 cl.	010	32°	Orth.	*Pinakiolite*	Bor.	Y = *c*. Red-br.: Y>X>Z	94
Y ⊥ 100 cl.	Prism.	38°	Orth.	*Hutchinsonite*	Tl, As, S	X = *b*. Scarlet. G. = 4.6	28
Z ‖ elong.	Lath	Mod.	Orth.	*Hewettite*	Van.	X, Y = yel.; Z = red. G. = 2.55	160
Z ‖ elong.	Lath	52°	?	*Metahewettite*	Van.	X = yel.; Y, Z = red. G. = 2.55	160
X ‖ elong.	Fib.	60°	Orth.	*Cuprodescloizite*	Van.	X = colorless; Y, Z = red-br.	133
X = *c*. Y = *b*	Pyr.	Lg.	Orth.	*Descloizite*	Van.	X = yel., Y = gr.-yel., Z = golden	133
X ⊥ 100 cl.	Prism.	82°	Orth.	*Laurionite*	Hal.	Y = *b*. Colorless to gray. G. = 6.2	38
D. No visible cleavage and biaxial with inclined extinction in axial zones							
001, 100	100	?	Mon.	*Fiedlerite*	Hal.	Z = *b*. G. = 5.9. Sol. HNO_3	39

001 dist.	Ps. Tet.	Sm.	Mon.?	*Schwartzembergite*	Hal.	$X = c\pm$. Yel. G. = 7.4	38
X ‖ elong.±	Fib.	Sm.	Mon.	*Vauquelinite*	Chrom.	Colorless or X = gr., Y, Z = br.	121
$X = c\pm$. $Z = b$	001	20°±	Mon.	*Polybasite*	Ag, Sb, S	Red. G. = 6.1. Dec. HNO_3	27
Y ⊥ 010 cl.	Prism.	40°	Mon.	Realgar	AsS	$X \wedge c = 11°$. Orange; pleo.	22
001 dist.	100	?	Mon.	*Paralaurionite*	Hal.	$Y = b$. Colorless or violet	39
111, 11$\bar{1}$, 001	Lath	?	Tr.	*Tenorite*	CuO	X = br., Z = opaque. G. = 6.4	41
			E. One or more visible cleavage directions and uniaxial				
110 perf.	001	0°	Tet.	*Lithargite*	PbO	Yel.-red. G. = 9.1	41
001 perf.	001	0°	Tet.	*Matlockite*	Hal.	Yel. or gr. G. = 7.2	37
001 perf.	001?	0°	Tet.	*Heterolite*	Ox.	Brown: X > Z. G. = 4.8±	65
0001 perf.	0001	0°	Hex.	*Hydrocerussite*	Carb.	G. = 6.8. Sol. HNO_3	82
0001 perf.	0001	0°	Hex.	*Bismite*	Ox.	G. = 4.36. Sol. HNO_3	43
0001 perf.	Rhom.	0°	Rhom.	*Chalcophanite*	Ox.	X = red, Z = opaque. G. = 3.9	66
10$\bar{1}$1 perf.	?	0°	Rhom.	*Geikielite*	$MgTiO_3$	Purple. G. = 3.9. Sol. HCl	67
02$\bar{2}$1, 10$\bar{1}$2	0001	0°	Rhom.	*Pyrophanite*	$MnTiO_3$	Yel.-red. G. = 4.5. Sol. HCl	67
			F. One or more visible cleavage directions and biaxial with parallel extinction in axial zones				
X ⊥ 010 cl.	Prism.	Sm.	Orth.	**Goethite**	Ox.	Yellow; pleo. G. = 4.2	47
010 perf.	Prism.	Sm.	Orth.	*Valentinite*	Sb_2O_3	$X = a$. Extr. Disp. G. = 5.76	45
X ⊥ 001 cl.	001	Sm.	Orth.	*Tungstite*	Ox.	Yellow: X > Y > Z. G. = 5.5	60
X ⊥ 001 cl.	001	19°	Orth.	*Pucherite*	Van.	$Z = b$. Red-br. G. = 6.25	138
Z ⊥ 010 cl.	Prism.	26°	Orth.	Stibnite	Sb_2S_3	$X = c$. Red to opaque. G. = 4.6	25
Z ⊥ 100 cl.	100	Lg.	Orth.	*Koechlinite*	Molyb.	$Y = c$. Yellow. Sol. HCl	107
			G. One or more visible cleavage directions and biaxial with inclined extinction in axial zones.				
001 perf.	001	10°	Mon.	*Leadhillite*	Sul.	$X \wedge c = 6°$. $Z = b$. G. = 6.3±	120
Y ⊥ 010 cl.	Fib.	20°	Mon.	*Emmonsite*	Tel.	X ⊥ 001? cl.±	118
101 perf.	El. ‖ b	20°	Mon.	*Terlinguaite*	Hal.	$Y \wedge c = 7°$. Yellow. G. = 8.7	39
001 perf.	100	30°	Mon.	*Baddeleyite*	ZrO_2	$X \wedge c = 12°$. $Y = b$. Gr., br. X > Z	60
100 perf.	001	65°	Mon.	*Smithite*	$AgAsS_2$	$Y = b$. $Z \wedge c = 7°$. Scarlet	27
001, 100	El. ‖ b	Lg.	Mon.	*Chloroxiphite*	Hal.	$X = c\pm$. $Z = b$. Y = br., Z = gr.	39

SUPPLEMENTARY TABLE II.—BIREFRINGENCE OF MINERALS

O. Birefringence zero: $N_g - N_p = 0.000$

Cleavage, Optic Orient.	Habit, etc.	Color	N	Mineral	Chem.	Other Characters	Page
Group 1. Refringence negative and distinct: $N < 1.48$							
A. Uncolored in thin section and not isometric							
None	Liquid	Colorless	1.333	*Water*	Ox.	G. = 1.0	40
B. Uncolored in thin section and isometric							
111 perf.	Oct.	Colorless	1.369	*Cryptohalite*	Hal.	G. = 2.00; sol. hot H_2O	36

I. Birefringence very weak: $N_g - N_p < 0.0035$

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 12. Refringence positive and high: N_o or $N_m > 1.74 < 2.00$. Optically + or −							
$Z = c$	?	0°	Tet.	*Cahnite*	Arsen.	Abn. int. colors	161
$Z = c$	?	0°	Hex.	*Abukumalite*	Sil.	G. = 4.35	*
II. Birefringence weak: $N_g - N_p > 0.0035 < 0.0095$							
Group 15a. Refringence negative and distinct: N_o or $N_m < 1.48$. Optically +.							
A. No visible cleavage							
$Z = c$	Rhom.	0°	Rhom.	*Schairerite*	Sul.	G. = 2.61. Sol. H_2O	119
$X = c$	010	11°	Orth.	*Feruccite*	$NaBF_4$	G. = 2.50. Sol. H_2O	**
$Y = b$	100	79°	Mon.	*Jarlite*	Hal.	$X \wedge \perp 100 = 16°$	***
B. One or more visible cleavages							
$Z \wedge cl. = 33°$	?	83°	Mon.?	*Bakerite*	Hal.	G. = 2.96	*4

Group 16a. Refringence negative and low: N_o or $N_m>1.48<1.54$. Optically +							
B. One or more visible cleavages							
X=*c*	Prism.	Lg.	Orth.	*Minyulite*	Phos.	G.=2.45	*5
?	?	Lg.	Orth.	*Ashtonite*	Sil.	Cleav. angles of 83° and 90°	432
100, 001	Prism.	65°	Mon.	*Dachiardite*	Sil.	X=*b*. $Z\wedge c=-35°$	399
Group 17a. Refringence positive and low: N_o or $N_m>1.53<1.59$. Optically +							
B. One or more visible cleavages							
Z⊥001 cl.	Pyr.	0°	Tet.?	*Wardite*	Phos.	G.=2.81	158
100, 001	Prism.	0°	Tet.	*Ashcroftine*	Sil.	G.=2.61	*6
Group 17b. Refringence positive and low: N_o or $N_m>1.53<1.59$. Optically −							
B. One visible cleavage							
001 perf.	001	70°	Mon.	*Dickite*	Sil.	$Y\wedge a=11°$	264
Group 18a. Refringence positive and moderate: N_o or $N_m>1.59<1.66$. Optically +							
A. No visible cleavage							
?	?	0°	Rhom.	*Deltaite*	Phos.	G.=2.95	155
Z ∥ elong.	Fib.	0°±	Orth.?	*Garnierite*	Sil.	Bluish green with X<Z	*7
B. One or more visible cleavages							
0001 perf.	Fib.	0°	Hex.	*Pseudowavellite*	Phos.	X ∥ fibers. G.=2.92	155
Group 18b. Refringence positive and moderate: N_o or $N_m>1.59<1.66$. Optically −							
A. No visible cleavage and no marked elongation							
X=*c*	Prism.	0°	Hex.	*Ellestadite*	Sil.	G.=3.07	*8

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SUPPLEMENTARY TABLE II.—BIREFRINGENCE OF MINERALS

II. Birefringence weak: $N_g - N_p > 0.0035 < 0.0095$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 18b. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically −, *continued*							
A. No visible cleavage and no marked elongation—*continued*							
Z ‖ fib.	Prism.	50°?	Orth.	*Juanite*	Sil.	H. = 5.5 Decomp. by acid	*
001, 100, 010	Prism.	65°	Orth.	*Tuhualite*	Sil.	X = *a*, Y = *b*; X = pink, Y = purple, Z = violet	**
C. One or more visible cleavages							
0001 perf.	Prism.	0°	Hex.	*Dehrnite*	Phos.	G. = 3.04	151
Group 19a. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +							
B. One or more visible cleavages							
001, 100	Col.	50°	Orth.	*Tawmawite*	Sil.	X = olive green, Y = brown, Z = emerald green	317
Group 20b. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically −							
?	?	5°	Orth.	*Calcium-larsenite*	Sil.	G. = 4.42	187
?	?	Biax.	?	*Lessingite*	Sil.	G. = 4.69	422
Group 21. Refringence positive and extreme: N_o or $N_m > 2.00$. Optically + or −							
X = *c*, Y = *a*	Ps. Hex.	Sm.	Orth.	*Britholite*	Sil.	Twins on 110	441
III. Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$							
Group 22a. Refringence negative and distinct: N_o or $N_m < 1.48$. Optically +							
A. No visible cleavage							
?	Powder	0°	Rhom.	*Tincalconite*	Bor.	G. = 1.88	90
Group 24a. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically +							
C. One visible cleavage							
Z ⊥ 0001 cl.	Lam.	0°	Rhom.	*Manganbrucite*	Ox.	Sol. HCl	42
D. Two or more visible cleavage directions							
100, 010	Prism.	70°	Tr.	*Bultfonteinite*	Sil.	$Z' \wedge c$ on 010 = 28°, G. = 2.73	***

Group 24b. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically −

A. No visible cleavage							
$X = c$	?	$0° \pm$	Tet.	*Aminoffite*	Sil.	G. = 2.94	*4
010 perf.	010	50°	Mon.	*Mooreite*	Sul.	$X = b$, $Z \wedge c = 44°$	106
$X \wedge b = 4° \pm$	Ps. Orth.	$60° \pm$	Tr.	*Leightonite*	Sul.	Blue. $Y \wedge c = 3°$	*5
B. One or more visible cleavage directions							
$X \perp 001$ cl.	001	61°	Orth.	*Saléite*	Phos.	G. = 3.1	*6
Group 25a. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +							
A. No visible cleavage							
010 perf.	001	?	Orth.	*Boehmite*	Ox.	Optic sign +?	46
$X = a$	010	15°	Orth.	*Roweite*	Bor.	G. = 2.92	*7
C. Two or more visible cleavage directions							
110	?	Var.	Orth.?	*Hydrophilite*	Hal.	Lamellar twinning	32
100, $\bar{1}02$, 001	Colum.	44°	Mon.	*Parawollastonite*	Sil.	G. = 2.91	*8
100, 010	Prism.	70°	Tr.	*Bultfonteinite*	Sil.	$Z' \wedge c$ on 010 = 28°	*9
Group 25b. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically −							
A. No visible cleavage							
X ‖ elong.	Fib.	Mod.	Orth.?	*Millisite*	Phos.	G. = 2.83	158
B. One visible cleavage							
0001 Perf.	?	0°	Hex.?	*Dennisonite*	Phos.	G. = 2.85	155
0001 Perf.	Prism.	Sm.	Hex.?	*Dehrnite*	Phos.	G. = 3.04	151
C. Two or more visible cleavage directions							
$X \perp 0001$ cl.	?	$0° \pm$	Hex.	*Lewistonite*	Phos.	G. = 3.06	151

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SUPPLEMENTARY TABLE II.—BIREFRINGENCE OF MINERALS

III. Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 26a. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +							
B. No visible cleavage and inclined extinction in the chief zones							
?	?	Mod.	Mon.	*Acrochordite*	Arsen.	$X = b$, $Y \wedge c = 40°–45°$	137
C. One visible cleavage							
0001 perf.	Plates	0°–20°	Rhom.	*Woodhouseite*	Sul.	G. = 3.01. Sol. HCl	*
D. Two or more visible cleavage directions							
$10\bar{1}0$	Prism.	0°	Hex.	*Bromellite*	Ox.	G. = 3.02	**
110	Lam.	Mod.	Orth.?	*Hydrophilite*	Hal.	Lamellar twinning	32
Group 26b. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically −							
A. No visible cleavage and uniaxial							
$X \perp 001$ cl.	Prism.	0°	Tet.	*Iron-akermanite*	Sil.	G. = 3.23	209
B. No visible cleavage and biaxial							
$X \parallel$ needles	Prism.	Mod.	Orth.	*Gageite*	Sil.	G. = 3.58	***
C. One or more visible cleavage directions							
001, 010	?	Lg.	Orth.	*Landesite*	Phos.	$X = c$, $Y = a$; X = dark brown, Y = light brown, Z = yellow	151
110 perf.	Prism.	Lg.	Mono.	*Ferrotremolite*	Sil.	$Y = b$, $Z \wedge c = 10°$	247
Group 27a. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +							
A. No visible cleavage							
$X = c$	Prism.	0°	Hex.	*Hedyphane*	Phos.	Bluish in mass	132
$X \wedge c = 45°$	Prism.	37°	Mon.	*Synadelphite*	Arsen.	$Z = b$. G. = 3.57	155

				B. One or more visible cleavage directions			
001, 010, 100	?	Mod.	Orth.	*Alluaudite*	Phos.	Z⊥best cl.	*4
001, 010	Prism.	70°	Orth.	*Varulite*	Phos.	Y=*b*. Optic sign +?	*5
?	?	68°	Mon.	*Repossite*	Phos.	G.=3.74.	*6
				Group 27b. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically −			
?	?	5°	Orth.	*Calcium-larsenite*	Sil.	G.=4.42	187
X∧*c*=32°	?	?	Mon.	*Nagatelite*	Sil.	Y=*b*; X=brownish yellow, Y=reddish brown, Z=pale yellow	317
				IV. Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$			
				Group 29a. Refringence negative and distinct: N_o or $N_m < 1.48$. Optically +			
?	Var.	80°	Mon.	*Lapparentite*	Sul.	G.=1.89	*7
				Group 30b. Refringence negative and low: N_o or $N_m > 1.48 < 1.54$. Optically −			
				A. No visible cleavage			
001 poor	?	52°	Mon.	*Letovicite*	Sul.	X∧*c*=17°, Z=*b*. G.=1.81	97
				Group 31b. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically −			
				B. One visible cleavage and parallel extinction			
X⊥001 cl.	001?	15°	Orth.	*Foshallasite*	Sil.	G.=2.5	*8
X⊥cl.	Platy	Sm.	Orth.	*Truscottite*	Sil.	Silky luster	409
X⊥001 cl. ±	Lam.	Var.	Mon.?	*Skolite*	Sil.	Slowly sol. in acid	*9
				C. One visible cleavage and inclined extinction			
X⊥001 cl. ±	001	24°	Mon.	*Hydrocalumite*	Ox.	Y=*b*. G.=2.15	*10

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SUPPLEMENTARY TABLE II.—BIREFRINGENCE OF MINERALS

IV. Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 32a. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +							
B. One visible cleavage							
001 perf.	Lam.	74°	Mon.	*Scawtite*	Sil.	$Y = b$; $Z \wedge a = 20°$	442
C. Two or more visible cleavage directions							
Four cl.	Platy	80°	Tr.	*Collinsite*	Phos.	G. = 2.95. Sol. in acid	128
X⊥001 cl.	Lam.	0° ±	Mon.	*Schuchardtite*	Sil.	X = *blue-green*, Z = olive	*
Group 32b. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically −							
A. No visible cleavage							
$X = c$	Prism.	0°	Tet.	*Mitscherlichite*	Hal.	Greenish blue	34
B. One visible cleavage and uncolored							
001, 010	?	66° ±	Tr.	*Sanbornite*	Sil.	Multiple twinning. G. = 4.19	407
Group 33a. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +							
A. No visible cleavage							
?	?	0° ±	Orth.	*Erikite*	Phos.	G. = 3.78	**
B. One or more visible cleavage directions and parallel extinction in chief zones							
100 dist.	010	Mod.	Mon.	*Larnite*	Sil.	$X \wedge c = 13°–14°$; $Z = b$.	194
Group 33b. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically −							
A. No visible cleavage							
$Z = c$	Prism.	40°	Orth.	*Seamanite*	Phos.	$Y = b$. G. = 3.13	161
?	Gran.	70° ±	?	*Metahohmanite*	Sul.	X = *yellow*, Y = red yellow, Z = brown	***
B. One visible cleavage							
X⊥100 cl.	100	70°	Orth.	*Renardite*	Phos.	$Y = c$. G. = 4. X = colorless, Y and Z = yellow	148

Group 34a. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +

110 dist.	Prism.	47°	Orth.	*Austinite*	Arsen.	$Y=a$; $Z=b$. G. = 4.12	*4
Plates	100	Lg.	Orth.	*Dumontite*	Phos.	$Y=c$; $Z=a$	148

Group 34b. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically −

$Y=c$	Ps. Tet.	Sm.	Orth.	*Allodelphite*	Sil.	G. = 3.57	440

V. Birefringence strong: $N_g - N_p > 0.0275 < 0.0365$

Group 37b. Refringence negative and low: N_o or $N_m > 1.48 < 1.54$. Optically −

100	Prism.	38°	Mon.	*Hexahydrite*	Sul.	$X \wedge c = -25°$. $Y=b$	106
$X=b$	Prism.	Lg.	Mon.	*Inderite*	Bor.	$Z \wedge c = 5°$	*5
110 perf.	Prism.	73°	Mon.	*Probertite*	Bor.	$Y=b$; $Z \wedge c = 12°–13°$	93

Group 38b. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically −

A. No visible cleavage

$X=c$	?	0°	Hex.	*Fluoborite*	Bor.	G. = 2.9	92

Group 39a. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +

A. No visible cleavage

$Z \wedge c = +28°$	Acic.	Mod.	Mon.	*Weinschenkite*	Phos.	$X=b$. Sol. acid	142

B. One or more visible cleavage directions

100 perf.	?	90°±	Mono.?	*Tilleyite*	Sil.	$X \wedge c = 18°$. $Y=b$	*6
010, 100	010	35°	Mono.	*Hilgardite*	Bor.	$Y=b$. $Z \wedge c = 1.5°$	*7
001, 110	010	Lg.	Tr.?	*Monetite*	Phos.	$Y=b±$. G. = 2.92	123

* K. Spangenberg: *Zent. Mineral.* 1938, A, p. 360.
** V. I. Gerasimovsky: *Trans. Lomonossov Inst. Geochem. Cryst. Mineral.*, X, 1937, p. 5.
*** M. C. Bandy: *Am. Mineral.*, XXXIII, 1938, p. 714.
*4 L. W. Staples: *Am. Mineral.*, XX, 1935, p. 112.
*5 A. Boldyrava: *Mem. Soc. Russe Mineral.*, LXVI, 1937, p. 651.
*6 E. S. Larsen and K. C. Dunham: *Am. Mineral.*, XVIII, 1933, p. 469.
*7 C. S. Hurlbut and R. E. Taylor: *Am. Mineral.*, XXII, 1937, p. 1052.

SUPPLEMENTARY TABLE II.—BIREFRINGENCE OF MINERALS

V. Birefringence strong: $N_g - N_p > 0.0275 < 0.0365$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 39b. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically −							
B. One or more visible cleavage directions and colorless							
X⊥0001 cl.	0001	0°	Hex.	*Portlandite*	Ox.	G. = 2.33. Sol. HCl	*
Group 40a. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +							
C. Two or more visible cleavage directions							
001, 100	El. ‖ b	35°	Mon.	*Serandite*	Sil.	$X \wedge a = -57°$. $Z = b$. G. = 3.21	418
110 at 87°	Prism.	70°	Mon.	*Johannsenite*	Sil.	$Y = b$. $Z \wedge c = 48°$	**
Group 40b. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically −							
A. No visible cleavage							
?	Fib.	Lg.	Mon.	*Lehiite*	Phos.	Lg. extinction angle. G. = 2.89	158
100 dist.	?	Lg.	Mon.	*β-Uranotile*	Sil.	$X = b$. $Y \wedge c = 49°$	***
Group 41a. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +							
110 at 89°	?	Sm.	Mon.	*Clinoferrosilite*	Sil.	$Y = b$. $Z \wedge c = 34.5°$	*4
001, 110	?	?	Tr.?	*Vandenbrandeite*	Uran.	Optic sign uncertain	*5
Group 41b. Refrigence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically −							
X⊥cl.	0001	0°	Rhom.?	*Taosite*	Ox.	X = yellow, Z = red brown	*6
010 dist.	?	53°	Orth.	*Arsenoclasite*	Arsen.	G. = 4.16. $X = b$, $Y = a$.	133
001?	El. ‖ b	Mod.	Mon.	*Sursassite*	Sil.	$X \wedge a = 55°$. G. = 3.25	438
$Z = b$	?	72°	Mon.	*Alleghanyite*	Sil.	$X \wedge a = 35°$	*7
VI. Birefringence very strong: $N_g - N_p > 0.0365 < 0.0545$							
Group 43. Refringence negative and distinct: N_o or $N_m < 1.48$. Optically + or −							
?	Tabular	56°	Orth.	*Mercallite*	Sul.	G. = 2.31	*8

Group 44b. Refringence negative and low: N_o or $N_m > 1.48 < 1.54$. Optically −							
0001 perf.	Plates	0°	Rhom.	*Ungemachite*	Sul.	G. = 2.29	*9
X = *c*	?	34°	Orth.	*Burkeite*	Sul.	G. = 2.57	*10
Group 45a. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically +							
010, 100	010	73°	Tr.	*Gordonite*	Phos.	X⊥010±. G. = 2.28	157
Group 45b. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically −							
X⊥001 cl.	001	5°	?	*Dakeite*	Carb.	G. = 2.51. Yellow	*11
Group 46a. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +							
A. No visible cleavage							
Y = *b*	El. ∥ *b*	64°	Mon.	*Loseyite*	Carb.	G. = 3.27. Sol. HCl	84
B. One or more visible cleavage directions							
Pin. good	Crust	80° ±	Orth.	*Louderbackite*	Sul.	G. = 2.19. Sol. H_2O	116
Group 47b. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically −							
B. One or more visible cleavage directions							
X⊥001 cl.	?	0°	Tet.	*Bandylite*	Bor.	G. = 2.81	*12
Group 48a. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +							
Z = *b*	Var.	40°	Mon.?	*Plumbosynadelphite*	Arsen.	G. = 3.79	*13

* C. E. Tilley: *Mineral. Mag.*, XXIII, 1933, p. 419.
** W. T. Schaller: *Am. Mineral.*, XVIII, 1933, p. 1131; XXIII, 1938, p. 575.
*** R. Nováček: *Mineral. Abst.*, VI, 1935, p. 148.
*4 N. L. Bowen: *Am. Jour. Sci.*, XXX, 1935, p. 481.
*5 A. Schoep: *N. Jahrb. Mineral.*, 1933, I, p. 250.
*6 J. de Lapparent: *Comp. Rend.*, 201, 1935, p. 154.
*7 A. F. Rogers: *Am. Mineral.*, XX, 1935, p. 25.
*8 G. Carobbi: *Mineral. Abst.*, VI, 1935, p. 148.
*9 M. A. Peacock and M. C. Bandy: *Am. Mineral.*, XXIII, 1938, p. 314.
*10 W. F. Foshag: *Am. Mineral.*, XX, 1935, p. 50.
*11 E. S. Larsen and F. A. Gonyer: *Am. Mineral.*, XXII, 1937, p. 561.
*12 C. Palache and W. F. Foshag: *Am. Mineral.*, XXIII, 1938, p. 85 (also p. 704).
*13 C. S. Hurlbut: *Am. Mineral.*, XXII, 1937, p. 526.

SUPPLEMENTARY TABLE II.—BIREFRINGENCE OF MINERALS

VI. Birefringence very strong: $N_g-N_p>0.0365<0.0545$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 48b. Refringence positive and very high: N_o or $N_m>1.74<2.00$. Optically −							
A. No visible cleavage							
?	Prism.	5°±	Mon.	*Fersmanite*	Tet.	$Y=b$. $X\perp 001\pm$. Brown	168
B. One or more visible cleavage directions							
120 dist.	Prism.	80°	Orth.	*Larsenite*	Sil.	G.=5.9. $X=a$; $Y=c$	187
Y ‖ elong.	?	Sm.	Orth.?	*β-Uranopilite*	Sul.	Z in 010	*
$Y\perp 001$ cl.	?	49°	Orth.	*Talasskite*	Sil.	$X=b$. G.=4.1	**
100 perf.	Ps. Orth.	49°	Tr.	*Yeatmanite*	Sil.	G.=4.8. $Z\wedge c=3.5°$	***
Group 49b. Refringence positive and extreme: N_o or $N_m>2.00$. Optically −							
?	Tab.	Lg.	Orth.?	*Duftite*	Phos.	G.=6.19. Sol. acid	132
?	Fib.	Sm.	Mon.	*Fervanite*	Van.	Extinction slightly inclined	142

VII. Birefringence extreme: $N_g-N_p>0.0545$

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 51a. Refringence negative and low: N_o or $N_m>1.48<1.54$. Optically +							
110 perf.	Prism.	53°	Orth.	*Nesquehonite*	Carb.	$X=a$. $Y=c$. G.=1.85	84
010 perf.	?	42°	Mon.	*Ginorite*	Bor.	$Y=b$. G.=2.09	*4
010, 111	Tablets	75°	Mon.	*Nahcolite*	Carb.	$X\wedge c=+27.5°$	*5
?	?	60°	Tr.	*Ammonioborite*	Bor.	Ext. 7° to 13°	91
Group 52a. Refringence positive and low: N_o or $N_m>1.54<1.59$. Optically +							
$Z=c$	Acic.	0°	Tet.	*Julienite*	CSN +	G.=1.65. Sol. H_2O	*6
010 perf.	Fib.	37°	Mon.	*Veatchite*	Bor.	$Y=b$. $Z\wedge c=-38°$. G.=2.69	*7
100, 010, 001	Prism.	60°	Orth.	*Metasideronatrite*	Sul.	$Y=b$; $Z=c$. Yellow: $X<Y<Z$	*8

		Group 52b. Refringence positive and low: N_o or $N_m > 1.53 < 1.59$. Optically −					
100, 010	Fib.	52°	Mon.	*Alumohydrocalcite*	Carb.	Ext. at 10° to fibers	88
		Group 53a. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +					
−Elong.	?	Sm.	Orth.	*β-Ascharite*	Bor.	G. = 2.65	*9
Perf.	Prism.	Sm.	Orth.	*Ransomite*	Sul.	G. = 2.63	116
001, 100	Cub. ±	Sm.	Mon.	*Guildite*	Sul.	G. = 2.72. Yellow	117
001, 100	Var.	Lg.	Mon.	*Krausite*	Sul.	G. = 2.84. $X \wedge c = -35°$. $Z = b$.	115
$Y = b$	Var.	80°	Mon.	*Szomolnokite*	Sul.	$X \wedge c = +26°$	*10
		Group 53b. Refringence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically −					
		A. No visible cleavage					
$Y = b$	Prism.	Lg.	Mon.	*Rogersite*	Sul.	$X \wedge c = 27°$	109
		B. One or more visible cleavage directions					
010, 110	Var.	Mod.	Tr.	*Castanite*	Sul.	$X \wedge c$ in 010 = 22°	110
		Group 54a. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +					
$Z = c$	Rhom.	0°	Hex.	*Synchysite*	Carb.	G. = 3.90	85
110, 001	Curved	75°	Orth.	*Antofagastite*	Hal.	Bluish green	*11
010, 100, 001	?	50°	Tr.	*Lopezite*	Chrom.	Opt. Pl. ⊥ 001 ±. Sol. H_2O	*12
?	Prism.	Mod.	Mon.	*Legrandite*	Arsen.	$X = b$. $Z \wedge c = -38° \pm$. Yellow with $Y < Z$	1[illegible]7

* R. Nováček: *N. Jahrb. Mineral.*, 1936, I, p. 141.
** V. D. Nikitin: *Mineral. Abst.*, VI, 1937, p. 438.
*** C. Palache, L. H. Bauer and H. Berman: *Mineral. Abst.*, VII, 1938, p. 14.
*4 G. d'Achiardi: *Mineral. Abst.*, V, 1934, p. 484.
*5 A. N. Winchell: Micro. Char. Art. Minerals, 2d Ed., New York, 1931, p. 199.
*6 A. Schoep and V. Billiet: *Zeit. Krist.*, XCI, 1935, p. 229.
*7 G. Switzer: *Am. Mineral.*, XXIII, 1938, p. 409.
*8 M. C. Bandy: *Am. Mineral.*, XXIII, 1938, p. 714.
*9 M. N. Godlevsky: *Mem. Soc. Russe Mineral.*, LXVI, 1937, p. 315.
*10 M. C. Bandy: *Am. Mineral.*, XXIII, 1938, p. 714.
*11 C. Palache and W. F. Foshag: *Am. Mineral.*, XXIII, 1938, p. 85.
*12 M. C. Bandy: *Am. Mineral.*, XXII, 1937, p. 929.

SUPPLEMENTARY TABLE II.—BIREFRINGENCE OF MINERALS

VII. Birefringence extreme: $N_g - N_p > 0.0545$—*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 54b. Refringence positive and high: N_o or $N_m > 1.66 < 1.74$. Optically −							
B. One visible cleavage							
X⊥001 cl.	001	74°	Orth.	*Bermanite*	Phos.	Y = *b*. X = light brown, Y = pale yellow, Z = red	*
010 perf.	Pyr.	Lg.	Orth.	*Butlerite*	Sul.	G. = 2.55	108
C. Two or more visible cleavage directions							
110 at 56°	Prism.	80°±	Mon.	*Kærsutite*	Sil.	Y = *b*; Z∧*c* = 2°±	254
Group 55a. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +							
A. No visible cleavage and not elongated or with negative elongation							
?	Var.	50°	Orth.	*Juaquinite*	Sil.	Y = *b*; Z = *c*. G. = 3.89	417
C. One or more visible cleavage directions							
010 dist.	Prism.	Lg.	Tr.	*Rossite*	Phos.	Z = *c*±. G. = 2.45	158
Group 55b. Refringence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically −							
A. No visible cleavage and uniaxial							
0001 dist.	0001	0°	Rhom.	*Argentojarosite*	Sul.	Yellow: X<Z	114
0001 dist.	0001	0°	Rhom.	*Ammoniojarosite*	Sul.	Yellow: X<Z	114
B. No visible cleavage and biaxial							
X ǁ Fib.	Fib.	Sm.	Orth.?	*Rosasite*	Carb.	X = colorless; Y = Z = pale bluish	84
C. One or two visible cleavage directions and uniaxial or 2V<40°							
X⊥100 cl.	100	Sm.	Orth.	*Ianthinite*	Ox.	Y = *c*. X = colorless, Y = violet, Z = dark violet	60
E. Three visible cleavage directions							
100+	Tab.	64°	Mon.	*Murmanite*	Sil.	X⊥100±. G. = 2.84	**

Group 56a. Refringence positive and extreme: N_o or $N_m > 2.00$. Optically +

D. One or more visible cleavage directions and prismatic elongation

011; 100 part.	Prism.	?	Orth.	*Bismutotantalite*	Tant.	G. = 8–8.4	167
100 or 110	?	?	Orth.	*Curite*	Uran.	X = c; Z = a. G. = 7.19, Optic sign +?	103

Group 56b. Refringence positive and extreme: N_o or $N_m > 2.00$. Optically −

C. No visible cleavage and biaxial

?	?	40°±	?	*Clarkeite*	Uran.	Orange. G. = 6.39.	111
One dist.	?	?	Orth.	*Psittacinite*	Van.	Biaxial	133

G. One or more visible cleavage directions and biaxial with inclined extinction

010 perf.	010	[illegible]	Mon.	*Lindgrenite*	Molyb.	Green. $X \wedge c = -7°$, Z = b	***

* C. S. Hurlbut: *Am. Mineral.*, XXI, 1936, p. 656.

** A. E. Fersman: *Mineral. Abst.*, II, p. 263; N. N. Gutkova: *Mineral. Abst.*, V, 1933, p. 198.

*** C. Palache: *Am. Mineral.*, XX, 1935, p. 484.

TABLE III.—COLOR OF MINERALS

COLORLESS minerals are not included in these tables, since they are so numerous that a special table would be too long to be worth while as compared with complete tables based on birefringence or refringence.

Many colored minerals are pleochroic, that is, they exhibit two different tints (true pleochroism) or shades (differential absorption) of color on rotation of the stage. Some minerals are not pleochroic, that is, they show just the same color in any section and in all positions of rotation. Isotropic minerals can not be pleochroic, but anisotropic minerals are not necessarily pleochroic (at least, not sensibly so). Accordingly, non-pleochroic colored minerals are of two kinds, isotropic and anisotropic.

Pleochroic minerals exhibit two (or more) different tints or shades [1] of color when the transmitted light vibrates first in one and then in a different unlike crystallographic direction. For example, a mineral shows two different tints when it is yellow for light vibrating parallel with the vertical axis and green for light vibrating normal thereto; it shows two different shades of color when it is pale blue (or red, etc.) in one position and dark blue (or red, etc.) in another position of rotation.

Minerals show all possible tints and shades of color, but the colors which are so common as to be important are: yellow, brown, red, blue, and green. A few minerals are gray in thin section.

The following tables are intended for use in the microscopic study of minerals; therefore minerals are included in the tables wholly on the basis of optic properties as observed in thin section or fine powder. For example, sulphur has a yellow color as observed in mass, but it is not included in the table of yellow minerals beginning on page 82, because it is colorless as observed under the microscope. Also, minerals, whose optic properties in thin section or fine powder are unknown, are not included in the tables. For example, lorettoite is orange yellow in mass and perhaps yellow in thin section; it is not

Two (or more) *shades* of color are strictly due to absorption rather than pleochroism, but may be included under pleochroism for convenience.

included in the table of yellow minerals beginning on page 83, because its pleochroic formula (if it is colored in thin section) is unknown. Again, annabergite, erinite, and cornwallite are pale green, but are omitted from the tables for the same reason.

On the other hand, minerals of variable optic properties are included in the tables in as many places as necessary to express all known variations in their properties.

In these tables "brown" includes not only light and dark brown, yellowish brown, red-brown, etc., but also shades such as cinnamon and chestnut brown; similarly, "blue" includes amethyst, indigo, lavender, lilac, purple and violet; "green" includes emerald, oil and olive, "red" includes carmine, cherry, claret, cochineal, crimson, magenta, pink, purple, rose, scarlet and vermilion; and "yellow" includes amber, canary, golden, lemon, ochre, orange, straw and wine colors.

For methods of estimating or measuring the index of refraction of minerals see the fifth edition of Part I, pages 75–85, 228–239 and 248–253.

For methods of estimating or measuring the birefringence of minerals see Part I, pages 116–124, and 135–137.

For definitions of X, Y, and Z see Part I, pages 117 and 160.

For methods of distinguishing between X, Y, and Z see Part I, pages 124, 130, 137, and 211.

For methods of determining pleochroic formulas, see Part I, pages 170, 171, 204, and 211.

For methods of determining the optic sign, see Part I, pages 129–132, 138, 148–154, 169, 206–213.

For methods of estimating or measuring the optic axial angle, see Part I, pages 186–189, 211, 226, and 245.

For methods of measuring extinction angles, see Part I, pages 126, 137, 173, 174, and 178.

Experienced mineralogists will realize that color is not a reliable means for identifying minerals. Many minerals may exhibit nearly any color, depending upon the presence or absence of small amounts of impurities or substances in crystal solution. Even though color in thin section is a more reliable guide than color in mass, it is not wise to rely wholly upon this table in the identification of unknown minerals. Nevertheless, color is so easily observed that this table seems desirable in spite of its inherent weakness.

Of course the intensity of color in minerals is even less constant than the color itself; nevertheless, some minerals are so often dark

colored, like biotite, or light colored, like ordinary chlorite, that it seems desirable to recognize this condition in the tables even though a color given as dark in the tables, for a certain mineral, may be light in that mineral in some cases, and *vice versa*. Accordingly, names of colors which usually appear notably dark in a given mineral are printed in bold-face type and those which usually appear light are printed in italics.

Names of minerals which are very common or very important are printed in bold-faced type, while names of rare minerals are printed in italics. Some unusually long mineral names are abbreviated to save space.

The tables based on color are arranged on the following outline: (the subdivisions are based on birefringence and the minerals in each subdivision are arranged in the order of increasing refringence).

COLORED MINERALS

I. Minerals pleochroic in yellow and blue.
II. Yellow minerals, not pleochroic, and isotropic.
III. Yellow minerals, not pleochroic, but anisotropic.
IV. Yellow minerals, pleochroic in yellow (including orange to colorless).
V. Minerals pleochroic in yellow and brown.
VI. Minerals pleochroic in yellow and red.
VII. Brown minerals, not pleochroic and isotropic.
VIII. Brown minerals, not pleochroic, but anisotropic.
IX. Brown minerals, pleochroic in brown.
X. Minerals pleochroic in brown and red.
XI. Red minerals, not pleochroic and isotropic.
XII. Red minerals, not pleochroic, but anisotropic.
XIII. Red minerals, pleochroic in red.
XIV. Minerals pleochroic in red and blue.
XV. Minerals pleochroic in brown and blue.
XVI. Blue minerals, not pleochroic and isotropic.
XVII. Blue minerals, not pleochroic, but anisotropic.
XVIII. Blue minerals, pleochroic in blue.
XIX. Minerals pleochroic in blue and green.
XX. Green minerals, not pleochroic and isotropic.
XXI. Green minerals, not pleochroic, but anisotropic.
XXII. Green minerals, pleochroic in green.
XXIII. Minerals pleochroic in green and yellow.
XXIV. Minerals pleochroic in green and brown.
XXV. Minerals pleochroic in green and red.
XXVI. Gray minerals.

TABLE III.—COLOR OF MINERALS

I. Minerals Pleochroic in Yellow and Blue

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
(a) Birefringence very weak or weak; $N_g - N_p < 0.0095$								
1.55±	*Yellow*	*Blue*	**Cordierite** *	Sil.	−	60°	Y = *violet*. Ps. Hex. twin.	307
1.6±	Yellowish	**Blue**	*Aerinite*	Sil.	−	Sm.	Y = Z. X⊥001 cleav.	285
1.66±	Yellow	**Violet**	*Crossite*	Sil.	−	Sm.	Y = blue. $X \wedge c = 70°±$	259
1.69±	**Gr.-blue**	Gr.-yellow	Arfvedsonite	Sil.	−	Lg.	Y = blue. $X \wedge c = 10°±$	257
1.695	**Blue**	Blue-gray	**Riebeckite**	Sil.	−	Lg.	Y = br.-yellow. 110 cl.	257
1.72	*Gr.-yellow*	Gr.-blue	*Sapphirine* *	Sil.	−	69°	Y = gr.-blue. $Z \wedge c = 10°±$	427
(b) Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$								
1.592	*Blue*	Gr.-yellow	*Torbernite*	Phos.	−	0°±	X⊥001 cleav. G. = 3.2	145
1.64±	Yellowish	Blue	Glaucophane	Sil.	−	45°±	Y = *violet*. $Z \wedge c = 5°±$	258
1.685	*Yellow*	*Greenish*	**Axinite** *	Sil.	−	75°±	Y = blue. X⊥011±	425
1.70±	*Red*	*Blue*	**HYPERSTHENE**	Sil.	−	70°±	Y = yellow. X = *a*. Z = *c*	219
1.72	Olive green	*Yellow*	Chloritoid	Sil.	−	50°±	Y = blue. 001 cleav.	438
(c) Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$								
1.623	Blue	*Gr.-yellow*	*Bazzite*	Sil.	−	0°	Hex. G. = 2.8. Insol.	414
1.63±	*Gr.-yellow*	Gr.-blue	**Pargasite**	Sil.	+	60°±	Y = green. $Z \wedge c = 28°±$	247
1.638	*Yellowish*	**Blue**	Glaucophane	Sil.	−	45°	Y = **violet.** $Z \wedge c = 5°±$	258
1.66±	*Yellow*	*Blue*	**Sillimanite** *	Sil.	+	30°	Y = *green*. Y = *a*. Z = *c*	200
1.67±	*Yellow*	**Blue, green**	**HORNBLENDE**	Sil.	−	80°±	Y = green. Y = *b*. $Z \wedge c = 20°±$	247
1.674	*Blue*	Colorless	Lawsonite *	Sil.	+	84°	Y = *yellow*. X = *a*. Z = *c*	430
(d) Birefringence strong to extreme: $N_g - N_p > 0.0275$								
1.668	**Blue**	Yel.-green	*Symplesite*	Arsen.	−	87°	Y = *gr.-yellow*. $Z \wedge c = 32°$	126
1.722	**Violet**	Yellowish	Diaspore	Ox.	+	84°	Y = ?. X = *c*. Z = *a*	46

1.74±	Yellow	Red	*Piedmontite*	Sil.	+	70°±	Y = violet. $X \wedge c = 7°$	315
2.146	Red-yellow	Red-yellow	*Rafaelite*	Hal.	?	?	Y = **Violet.** 100 twin.	39

II. Yellow Minerals, Not Pleochroic and Isotropic

N	Color	Mineral	Chem.	Cleav.	Other Characters	Page
1.434	Purple, yellow, etc.	Fluorite †	CaF_2	111 perf.	Color in spots	31
1.485	Yellow, blue, pink	**Sodalite**	Sil.	110 poor	G. = 2.4. Gel. HCl	289
1.49±	Blue, yellow, etc.	Noselite	Sil.	110 poor	G. = 2.4. Gel. HCl	290
1.5±	Orange	*Hisingerite*	Sil.	None	G. = 3. Dec. HCl	415
1.50±	Blue, yellow, etc.	Hauynite	Sil.	110 poor	G. = 2.4. Gel. HCl	290
1.64±	Ocher-yellow	*Lagonite*	Bor.	None	Soft. Very rare	94
1.64±	Brown, yellow	*Griphite*	Phos.	None	G. = 3.4. Sol. HCl	155
1.65±	Yellow±	*Diadochite*	Sul.	None	Opaline	121
1.652±	Green, yellow	*Greenalite* ‡	Sil.	None	G. = 2.8+. Sol. HCl	413
1.7±	Yellow, brown	*Thorite*	$ThSiO_4$	None	G. = 5.3±	185
1.73±	Red, blue, etc.	Spinel †	$MgAl_2O_4$	111 poor	G. = 3.6. H. = 8	62
1.739	Yellowish	*Helvite*	Sil.	111 poor	G. = 3.2. Gel. HCl	291
1.75±	Yellow	*Tritomite*	Sil.	None	G. = 4.2. Gel. HCl	420
1.75±	*Yellow, brown*	**Grossularite** †	Sil.	None	G. = 3.5±. Insol.	180
1.87±	Yellow, brown	**Andradite**	Sil.	None	G. = 4±. Insol.	180
2.1±	Yellow to red	**Limonite** ‡	Fe, O, H	None	G. = 3.8±	47
2.14±	Amber	*Yttrocrasite*	Tit.	?	G. = 4.8. Sol. H_2SO_4	167
2.346	Yellow	*Marshite*	CuI	110	Red when heated	30
2.4±	Brown, yellow	Sphalerite	ZnS	110 perf.	G. = 4.1. Sol. HCl	19
2.49 Li	Yellow ±	*Eglestonite*	Hg_4OCl_2	None	G. = 8.3. Volatile	37

* Usually colorless in section of standard thickness (.02-.03 mm.); pleochroic in thicker sections.

† Often colorless.

‡ Often opaque on account of surface reflection and refraction.

TABLE III.—COLOR OF MINERALS

III. Yellow Minerals, Not Pleochroic, But Anisotropic

N_o or N_m	Color	Mineral	Chem.	±	2V	Other Characters	Page
		(a) Birefringence very weak or weak: $N_g-N_p<0.0095$					
1.75±	*Yellow, brown*	**Grossularite** *	Sil.	±	Var.	No cleav. G.=3.5±	180
1.87±	Yellow, brown	**Andradite**	Sil.	±	Var.	No cleav. G.=4±	180
2.21	*Yellow* (zones)	*Weslienite*	Antim.	+	Sm.	Abn. int. colors	160
2.506	Yellow, orange	*Greenockite*	CdS	+	0°	$10\bar{1}0$ cleav. G.=4.8	21
		(b) Birefringence moderate or rather strong: $N_g-N_p>0.0095<0.0275$					
1.623	Lemon yellow	*Uranopilite*	Sul.	+	Lg.	Abn. int. colors	117
1.666	*Yellow*	*Johnstrupite* *	Sil.	+	70°	100 cleav. G.=3.3	423
1.73	*Yellow*	*Melanocerite*	Sil.	−	0°	No cleav. G.=4.13	420
1.733	***Yellowish***	*Hematolite*	Arsen.	−	0°	0001 cleav. G.=3.4	153
2.18	*Yellow*	*Kleinite*	Hg_2OCl_2	−	Sm.	One cleav. G.=7.98	38
		(c) Birefringence extreme: $N_g-N_p>0.0545$					
1.68±	Reddish yellow	*Erythrosiderite*	Hal.	−	65°±	X=*a*. Y=*c*. Deliques.	35
1.763	Canary yellow	*Dewindtite*	Phos.	+	Lg.	X=*a*. Y=*c*. 100 cleav.	148
1.997	*Brown, yellow*	Cassiterite	SnO_2	+	0°	G.=7±. Zonal	52
2.19	*Yellow, brown*	*Baddeleyite*	ZrO_2	−	30°	$X\wedge c=12°$. 001 cleav.	60
2.20	Canary yellow	*Tripuhyite*	Antim.	+	Sm.	G.=5.8. In gravels	160
2.24	Golden yellow	*Tungstite*	$WO_3.H_2O$	−	Sm.	X⊥001 cleav.	60
2.4±	Green-yellow	*Stibiotantalite*	Tant.	+	75°±	X⊥100 cleav. Z=*c*	167
2.50	Yellow	*Montroydite*	HgO	+	Lg.	010 cleav. Sol. HCl	41
2.61	**Brown, yellow**	**Rutile** †	TiO_2	+	0°	Tet. prism. G.=4.2	50
2.65 Li	Yellow-orange	*Lithargite*	PbO	−	0°	110 cleav. G.=9.13	41

IV. Yellow Minerals, Pleochroic in Yellow (Including Orange to Colorless)

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
			(a) Birefringence very weak or weak: $N_g - N_p < 0.0095$					
1.525±	Colorless	*Golden*	Sepiolite ‡	Sil.	−	Sm.	Y=Z. Z ‖ fibers	410
1.58±	*Yellow*	*Golden*	Beryl ‡	Sil.	−	0°	Hex. G.=2.8±	212
1.61±	Colorless	*Yellow*	*Eudialite* ‡	Sil.	+	0°	0001 cleav. Gel. HCl	417
1.63±	*Yellow*	Colorless	*Eucolite* ‡	Sil.	−	0°	0001 cleav. Gel. HCl	417
1.72	*Yellow*	Colorless	Vesuvianite	Sil.	−	0°	Tet. G.=3.4. Contacts	207
>1.74	*Yellow*	Br. yellow	*Schafarzikite*	Phos.	+	0°	110 cleav. G.=4.3	122
1.915	*Yellow*	?	*Huegelite*	Van.	+	Sm.	Y=orange. Abn. int. colors	127
1.93	Golden: X and Y<Z		*Corkite*	Sul.	−	0°	0001 cleav. G.=4.2±	119
			(b) Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$					
1.545	Colorless	*Yellow*	**Chrysotile** ‡	Sil.	+	30°±	Y=Z. Z ‖ fibers	260
1.591	*Yellow*	Yellow	*Metavoltine*	Sul.	−	0°	G.=2.53. Scaly	114
1.623	Colorless	*Yellow*	Uranocircite	Arsen.	−	10°±	X⊥001 cleav. Y=*b*	147
1.637	?	Colorless	Barite ‡	Sul.	+	37°	Y=**yellow.** X⊥001 cl.	100
1.654	Colorless	Red-yellow	*Hureaulite*	Phos.	−	74°	Y=*yellow.* Z∧*c*=75°	124
1.654	Colorless	*Yellow*	Phenakite ‡	Sil.	+	0°	11$\bar{2}$0 cleav. G.=3.0	185
1.657	Colorless	*Br. yellow*	*Seybertite*	Sil.	−	5°	Y=Z. X⊥001 cleav.	286
1.66	Colorless	Orange	*Salmonsite*	Phos.	+	Lg.	Y=yellow. Z ‖ fibers	156
1:666	*Yellow*	*Gr. yellow*	*Johnstrupite* ‡	Sil.	+	70°	Y=*br. yellow.* Y=*b*	423
1.668	*Yellow:* X<Y<Z		*Rinkite*	Sil.	+	43°	X=*b*. Y∧*c*=8°. 100 cl.	423
1.681	*Yellow*	Colorless	*Prismatine* ‡	Sil.	−	30°±	Y=*br. yellow.* X=*c*	421

* Often colorless.
† Often opaque in standard sections; colored in extremely thin sections.
‡ Usually colorless in sections of standard thickness (.02–.03 mm.); pleochroic in thicker sections.

TABLE III.—COLOR OF MINERALS

IV. Yellow Minerals, Pleochroic in Yellow (Including Orange to Colorless)—*continued*

(b). Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$—*continued*

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
1.686	Colorless	?	*Titanoelpidite*	Sil.	+	Mod.	Y=yellow. X=*b*. Y=*c*	400
1.695	Colorless	*Yellow*	*Guarinite*	Sil.	+	90°±	Y=*yellowish*. G.=3.27 (=Hainite?)	406
1.75	Colorless	Golden	**Staurolite**	Sil.	+	88°	Y=*yellowish*. Y=*a*. Z=*c*	202
1.96	Golden: X and Y<Z		*Beudantite*	Sul.	−	Mod.	0001 cleav. G.=4.1	119
2.135	Colorless±	*Yellow*	*Mimetite*	Arsen.	−	0°	Hex. Prism. G.=7.1	132
2.265	*Yellow*	Golden	*Descloizite*	Van.	−	Lg.	Y=gr.-yellow. X=*c*	133

(c) Birefringence ratner strong: $N_g - N_p > 0.0185 < 0.0275$

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
1.57	*Yellowish*	**Golden**	*Xylotile*	Sil.	+	Sm.	Y=X. Z ‖ fib. G.=2.5±	261
1.574	*Yellow*	**Yellow**	*Basseite*	Phos.	−	62°	Y=yellow. X⊥010 cleav.	146
1.575	Colorless	Golden	*Autunite*	Phos.	−	33°	Y=golden. X⊥001 cleav.	146
1.586	Colorless±	*Yellow*	*Uranospinite*	Arsen.	−	46°	Y=Z. X⊥001 cleav.	147
1.6±	*Yellow*	Golden	Bowlingite	Sil.	−	Sm.	Y=yellow. X⊥001 cleav.	437
1.613	*Gr.-yellow*	*Br.-yellow*	*Meliphanite* *	Sil.	−	0°	Tet. Pyram. 001 cleav.	210
1.62	*Yellowish*	Yellow	*Nontronite*	Sil.	−	Var.	Y=orange. X⊥001 cleav.	415
1.63	*Golden*	Colorless	*Carpholite*	Sil.	−	60°	Y=X. Y=*a*. Z=*c*. 010 cleav.	431
1.65±	Colorless±	Yellow	**Tourmaline**	Sil.	−	0°	Max. abs.⊥elong.	301
1.653	*Yellow*	Yellow	*Plumbogummite*	Phos.	+	0°	G.=4.5. Sol. HNO_3	153
1.666	Colorless	Yellow	*Uranophane*	Sil.	−	40°±	Y=*yellow*. Abn. int. colors.	441
1.716	*Yellow*	Wine yellow	*Woehlerite*	Sil.	−	75°	Y=X. X∧*c*=45°. 010 cl.	441
1.9±	**Br.-yellow**	*Yellow*	*Ardennite*	Sil.	+	70°	Y=golden. Y⊥010 cleav.	440
2.356	Yellow: X>Z		*Wurtzite*	ZnS	+	0°	$10\bar{1}0$ cleav. G.=4±	20

(d) Birefringence strong: $N_g - N_p > 0.0275 < 0.0365$

1.510	*Yellow*	**Yellow**	*Uranospathite*	Phos.	−	69°	Y = **yellow**. X⊥001 cleav.	146
1.57±	Colorless	*Br.-yellow*	**Phlogopite**	Sil.	−	10°	Y = Z. X⊥001 cleav.	272
1.576	Gr. yellow	*Yellow±*	*Parsettensite*	Sil.	−	0°	0001 cleav. Dec. HCl	407
1.62±	*Golden*	*Yellow*	Chondrodite	Sil.	+	80°±	Y = *yellow±*. $X \wedge a = 30°$	196
1.63±	*Golden*	*Yellow*	Humite	Sil.	+	68°	Y = colorless. $X = a$. $Z = b$	197
1.65±	*Yellow*	*Br.-yellow*	Cummingtonite	Sil.	+	80°±	Y = *yellow*. $Z \wedge c = 15°$	243
1.67±	*Golden*	*Yellow*	Clinohumite	Sil.	+	76°	Y = colorless. $X \wedge a = 10°$	197
1.68±	Br. yellow	Br. yellow	*Erythrosiderite*	Hal.	−	65°	Y = red-yellow. $X = a$. $Y = c$	35
1.687	*Yellow*: X and Y<Z		*Rosenbuschite*	Sil.	+	60°	001 cleav. $Z \wedge c = 13°$	419
1.687	Colorless	Yellow	*Schroeckingerite*	Carb.	−	40°	Abn. int. colors. 010 cl.	86
1.72	Colorless±	Yellow	*Phosphuranylite*	Phos.	−	0°	X⊥010 plates. Sol. HCl	147
1.74	*Yellow*	Straw yellow	*Molengraafite*	Sil.	+	28°	Y = colorless. $Z \wedge c$ = Sm.	418
1.75	*Yellow*	Golden	*Lamprophyllite*	Sil.	+	40°	Y = X. X⊥010 cleav.	418
1.75	Colorless	Golden	*Laavenite*	Sil.	−	80°	Y = X. 100 cleav. $X \wedge c = 20°$	420
2.27	Br.-yellow: X<Z		*Raspite*	$PbWO_4$	+	Sm.	100 cleav. $X \wedge c$ = Lg.	101

(e) Birefringence very strong: $N_g - N_p > 0.0365 < 0.0545$

1.534	Colorless±	*Yellow*	*Fibroferrite*	Sul.	+	0°±	Y = colorless±. Z ∥ fib.	109
1.535	Colorless	Orange-yellow	*Quetenite*	Sul.	+	34°	Y = X. 110 cleav. G. = 2.12	116
1.59±	Colorless	*Yellow*	**Fe-muscovite**	Sil.	−	Sm.	Y = Z. X⊥001 cleav.	268
1.595	Colorless	Yellow	*Johannite*	Sul.	+	Lg.	Y = *yellow*. $X = b±$	118
1.635	Colorless	Yellow	*Sklodowskite*	Sil.	−	Lg.	Y = *yellow*. Y⊥001 cleav.	441
1.662	Colorless	?	*Soddite*	Ox.	+	?	Y = yellow. $X = a$. $Z = c$	61
1.673	Orange-yellow	Colorless	*Durangite*	Arsen.	−	57°	Y = *orange-yellow*	151
1.697	Colorless	*Yellow*	Grunerite	Sil.	−	82°	Y = X. $Y = b$. $Z \wedge c = 12°±$	242
1.714	Colorless	Yellow	*Schoepite*	$UO_3 \cdot 2H_2O$	−	Lg.	Y = Z. X⊥001 cleav.	60
1.77	?	**Yellow**	*Becquerelite*	$UO_3 \cdot 2H_2O$	−	Sm.	Y = yellow. X⊥001 cleav.	60

* Usuallly colorless in standard sections; may be pleochroic in thicker sections.

TABLE III.—COLOR OF MINERALS

IV. Yellow Minerals, Pleochroic in Yellow (Including Orange to Colorless)—*continued*

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
			(e) Birefringence very strong: $N_g-N_p>0.0365<0.0545$—*continued*					
1.79	Yellow	Gr.-yellow	Monazite	Phos.	+	12°	Y=**yellow**. $Z\wedge c=4°$	138
1.815	*Yellow*	Orange	*Pascoite*	Van.	−	50°	Y=yellow. $X=b$. $Z\wedge c=8°$	160
1.864	*Yellowish*	*Yellowish*	*Knebelite* *	Sil.	−	50°±	Y=*yellow*. X⊥010 cleav.	193
1.877	*Gr.-yellow*	*Gr.-yellow*	**Fayalite** *	Sil.	−	50°	Y=*orange*. X⊥010 cl.	192
			(f) Birefringence extreme: $N_g-N_p>0.0545$					
1.525	Colorless	*Amber-yellow*	*Sideronatrite*	Sul.	+	58°	Y=*yellow*. X⊥100 cl.	115
1.54±	Yellow	Gr.-yellow	*Mono. copiapite*	Sul.	+	Lg.	Y=colorless. $Z\wedge c=50°$	108
1.580	*Yellowish*	Orange	*Cacoxenite*	Phos.	+	0°	Z ‖ fib. G.=3.38	143
1.605	Colorless±	Orange	*Amarantite*	Sul.	−	28°	Y=*orange*. 100, 010 cl.	109
1.66	Colorless	Yellow	*Stewartite*	Phos.	−	Lg.	Y=*yellow*. 010 cleav.	128
1.672	*Yellow*	*Golden*	*Parisite* *	Carb.	+	0°	0001 cleav. G.=4.4	85
1.680	Colorless±	Yellow	*Zippeite*	Sul.	−	Lg.	Y=yellow. X⊥010 cleav.	110
1.703	**Golden**	Lemon yellow	*Astrophyllite*	Sil.	+	75°±	Y=orange. X⊥010 cl.	417
1.734	Yellow: X<Y<Z		*Curtisite*	$C_{60}H_{40}O$	+	83°	Z⊥001 cleav.	18
1.755	*Yellow*	Br. yellow	*Vegasite*	Sul.	+	0°	Z⊥0001 plates	116
1.76±	Clear yellow	Gray-yellow	*Ferrimolybdite*	Molyb.	+	28°	Y=X. $X=b$. Z ‖ fib.	108
1.760	Br.-yellow	Gr.-yellow	*Cordylite* *	Carb.	−	0°	0001 cleav. G.=4.3	86
1.820	Colorless	Yellow	*Jarosite*	Sul.	−	0°	0001 cleav. G.=3.2	114
1.832	Colorless	*Yellow*	*Natrojarosite*	Sul.	−	0°	0001 cleav. G.=3.18	114
1.9±	Gray-yellow	Yellow	*Carnotite*	Van.	−	45°	Y=Z. X⊥001 cleav.	148
1.9±	Colorless±	Yellow	*Tyuyamunite*	Van.	−	45°	Y=Z. X⊥001 cleav.	147
1.905	*Br. yellow*	*Yellow*	**Titanite** *	Sil.	+	28°	Y=X. Str. disp.	204

1.95±	Colorless	*Yellow*	*Durdenite*	Tel.	−	23°	Y=*yellow*. X=*c*	118
1.997	*Br.-yellow*	*Golden*	Cassiterite	SnO_2	+	0°	G.=7±. Zonal.	52
2.20	Yellow	Br.-yellow	*Lepidocrocite*	FeO(OH)	+	83°	Y=orange. X⊥010 cl.	48
2.24	Yellow: X>Y>Z		*Tungstite*	$WO_3 \cdot H_2O$	−	Sm.	X⊥001 cleav. Sol. KOH	60
2.30	Yellow	Orange	**Goethite**	FeO(OH)	−	Var.	Y=br.-yellow. Extr. disp.	47
2.354	*Yellow*	*Orange*	Vanadinite	Van.	−	0°	Hex. Prism. Dec. HCl	131
2.37	Gr.-yellow	Red-yellow	*Crocoite*	$PbCrO_4$	+	57°	Y=? Y=*b*. Z∧*c*=6°	101
2.402	Yellow, etc.: X<Z		Wulfenite	$PbMoO_4$	−	0°	Tet. 111 cleav. G.=6.9	98
2.56	*Yellow*	*Orange*	*Octahedrite*	TiO_2	−	0°	001 cleav. G.=3.9. Insol.	53
2.58	Orange	Yellow	*Brookite*	TiO_2	+	Var.	Y=X. Abn. int. colors	59
2.61 Li	*Yellow*	Yellow	*Massicotite*	PbO	+	Lg.	Y (or X?)⊥100 cleav.	41
2.61	Yellow	**Br.-yellow**	**Rutile ‡**	TiO_2	+	0°	Tet. Prism. G.=4.2	50
2.72+	Yellow: X>Y and Z		Orpiment *	As_2S_3	+	Sm.	X⊥010 cleav. Z=*a*±	25

V. Minerals Pleochroic in Yellow and Brown

(a) Birefringence very weak to moderate: $N_g - N_p < 0.0185$

1.543	*Yellow*	*Yel.-brown*	**Cordierite ***	Sil.	−	60°±	Y=*brown*. Ps. Hex. twin.	307
1.62	Yel.-brown	Yellow	*Nontronite*	Sil.	−	Var.	Y=? X⊥001 cleav.	415
1.620	*Red-brown*	*Yellow*	*Goyazite* *	Phos.	+	0°	0001 cleav.	153
1.685	*Brown*	*Olive-yellow*	**Axinite ***	Sil.	−	75°	Y=*violet*. X⊥011±	425
1.72	*Br.-yellow*	*Yel.-brown*	Vesuvianite *	Sil.	−	0°	Poor cleav. G.=3.4	207

(b) Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$

1.64	*Brown*	*Yellow*	**Anthophylite ***	Sil.	+	Lg.	Y=X. Z=*c*. 110 cleav.	240
1.65	*Yellow*	**Brown**	**Tourmaline**	Sil.	−	0°	Max. abs.⊥ elong.	301
1.69	*Yellow*	Brown	Barkevikite	Sil.	−	40°±	Y=red-brown. Z∧*c*=12°	254
1.70	Brown	*Yellow*	**Pigeonite**	Sil.	+	Sm.	Y=X. Y=*b*. Z∧*c*=30°±	222
2.36	Yellow	Brown	*Wurtzite*	ZnS	+	0°	$10\bar{1}0$ cleav. G.=4±	20

* Usually colorless in sections of standard thickness (.02–.03 mm.); pleochroic in thicker sections.

‡ Often opaque in standard sections; colored in extremely thin sections.

TABLE III.—COLOR OF MINERALS

V. Minerals Pleochroic in Yellow and Brown—*continued*

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
(c) Birefringence strong to very strong: $N_g - N_p > 0.0275 < 0.0545$								
1.625	Yellow	Brown	*Roscherite*	Phos.	−	Lg.	Y = yel.-brown. 001 cl.	156
1.63±	Yellow	**Red-brown**	**BIOTITE**	Sil.	−	Sm.	Y = Z. X ⊥ 001 cleav.	227
1.63±	Yellow	**Brown**	Anomite	Sil.	−	Sm.	Y = Z. X ⊥ 001 cleav.	276
1.63±	Yellow	Brown	*Protolithionite*	Sil.	−	Sm.	Y = Z. X ⊥ 001 cleav.	270
1.65	Colorless	*Yellow*	*Reddingite*	Phos.	+	40°	Y = brown; Y ⊥ 010 cl.	124
1.70±	Yellow	**Green, brown**	**HORNBLENDE**	Sil.	−	80°±	Y = brown. $Z \wedge c = 20°$±	247
1.722	Brown	*Yellowish*	Diaspore *	AlO(OH)	+	84°	Y = ? Y ⊥ 010 cleav.	46
1.734	Rose-red	Yellow	*Adamite*	Phos.	+	83°	Y = yel.-brown, $X = a$	133
1.75	Green	Yellow	**EPIDOTE** †	Sil.	−	70°±	Y = brown. $Z \wedge a = 25°$	314
1.776	**Red-brown**	Br.-yellow	*Orientite*	Sil.	+	67°	Y = yellow. $X = a$. $Y = c$	432
1.79	Br.-yellow	Br.-yellow	Monazite *	Phos.	+	12°	Y = red-brown. $X = b$	138
1.81	X or Z = Gr.-yellow		*Hancockite*	Sil.	−	50°	Y = yel.-brown. 001 cl.	316
1.845	*Yellow*	**Red-Brown**	*Kraurite*	Phos.	+	Sm.	Y = Z. $X = a$. $Y = c$	142
1.9±	**Br.-yellow**	**Green**	Ilvaite ‡	Sil.	−	Sm.	Y = **brown**. $Z = c$	431
(d) Birefringence extreme: $N_g - N_p > 0.0545$								
1.685	*Gr.-yellow*	Brown	*Roscoelite*	Sil.	−	Sm.	Y = Z. X ⊥ 001 cleav.	270
1.69	Yellowish	**Brown**	*Stilpnomelane*	Sil.	−	Sm.	Y = Z. X ⊥ 001 cleav.	435
1.77	*Yellow*	**Red-brown**	*Chalcodite*	Sil.	−	Sm.	Y = Z. X ⊥ 001 cleav.	435
1.87	Yellow	Red-brown	*Arseniosiderite*	Arsen.	−	0°	001 cleav. G. = 3.7±	153
1.879	*Br.-yellow*	Gr.-yellow	*Uvanite*	Van.	+	52°	Y = **brown**. 2 cleav.	148
2.19	Brown	Brown	*Baddeleyite*	ZrO_2	−	30°	Y = gr.-yellow. $X \wedge c = 12°$	60
2.22 Li	Golden	Gr.-yellow	Huebnerite	$MnWO_4$	+	73°	Y = yel.-brown. $Z \wedge c = 20°$	101
2.25	Br.-yellow: X < Z		*Manganite* ‡	MnO(OH)	+	Sm.	Y = X. Y ⊥ 010 cleav. $Z = c$	48
2.3±	Brown	Orange	**Goethite**	FeO(OH)	−	Var.	Y = br.-yellow. Ext. disp.	47

VI. Minerals Pleochroic in Yellow and Red

			(a) Birefringence very weak: $N_g - N_p < 0.0095$					
1.328	Golden	Carmine	*Villiaumite*	NaF	−	?	100 cleav. X⊥001	30
1.61±	*Golden*	*Carmine*	*Eudialite* §	Sil.	+	0°	0001 cleav. Gel. HCl	417
1.63±	*Carmine*	*Yellow*	*Eucolite* §	Sil.	−	0°	0001 cleav. Gel. HCl	417
1.70	**Pink**	Yellow	*Thulite*	Sil.	+	Sm.	Y=*pink*. X⊥010 cl.	311
			(b) Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$					
1.62	*Yellow*	*Violet pink*	Topaz §	Sil.	+	60°±	Y=*pink*. Z⊥001 cleav.	198
1.64	*Red*	*Yellow*	**Andalusite** §	Sil.	−	84°	Y=Z. X=*c*. Z=*a*. 110 cl.	201
1.67±	**Pink**	*Pink*	Lithiophilite	Phos.	+	65°±	Y=*gr.-yellow*. Y⊥001 cl.	149
1.70±	*Red*	*Blue*	**Hypersthene**	Sil.	−	70°±	Y=*yellow*. X=*a*. Z=*c*	219
1.73±	*Red-yellow*: X>Z		Rhodonite §	Sil.	−	76°	Y=*pink*. 110, 1$\bar{1}$0 cl.	403
			(c) Birefringence rather strong to strong: $N_g - N_p > 0.0185 < 0.0365$					
1.548	Yellow	*Orange-red*	*Botryogen*	Sul.	+	41°	Y=*red*. X⊥010 cleav.	116
1.660	*Yellowish*	Colorless	*Eosphorite*	Phos.	−	40°	Y=**pink.** Y⊥100 cleav.	156
1.678	**Blood-red**	Orange	*Titanclinohumite*	Sil.	+	60°±	Y=Z. X∧001 cleav.=8°. Z=*b*	198
1.70	Gr.-yellow	Gr.-yellow	**AUGITE** (Ti)	Sil.	+	60°	Y=red. X∧*c*=45°±. Y=*b*	228
1.735	Orange-red	*Yellow*	*Sicklerite*	Phos.	−	Lg.	Y=orange. Z⊥cleav.	158
1.75	*Wine yellow*	Orange-red	*Laavenite*	Sil.	−	80°	Y=*gr.-yellow*. X∧*c*=20°	420
1.852	Gr.-yellow	*Pink*	*Törnebohmite*	Sil.	+	26°	Y=bl.-green. Rare	414
			(d) Birefringence very strong: $N_g - N_p > 0.0365 < 0.0545$					
1.70	*Yellow*	**Yellowish-red**	*Neptunite*	Sil.	+	49°	Y=Z. Y=*b*. Z∧*c*=20°	418
1.722	Blue	Violet	**Diaspore** §	AlO(OH)	+	84°	Y=yellow. Y⊥010 cl.	46

* Usually colorless in sections of standard thickness (.02–.03 mm.); pleochroic in thicker sections.
† Usually pleochroic greenish to golden yellow in sections of standard thickness; colored as given above in thicker sections.
‡ Usually opaque in sections of standard thickness (.02–.03 mm.); pleochroic in extremely thin flakes or on thin edges.
§ Usually colorless in sections of standard thickness (.02–.03 mm.); colored in thicker sections.

TABLE III.—COLOR OF MINERALS

VI. Minerals Pleochroic in Yellow and Red—*continued*

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
			(d) Birefringence very strong: $N_g-N_p>0.0365<0.0545$—*continued*					
1.734	Rose-red	Yellow	*Adamite*	Arsen.	+	83°	Y=yel.-brown. X=*a*	133
1.74	Yellow	Red	*Piedmontite*	Sil.	+	70°±	Y=violet. Z∧001 cleav.=32°	315
1.75±	Yellow	Pink	**EPIDOTE** *	Sil.	−	70°±	Y=green. Z∧001 cleav.=25°	314
2.10	*Orange*	**Red**	*Metahewettite*	Van.	−	52°	Y=red. Z ‖ elong.	160
			(e) Birefringence extreme: $N_g-N_p>0.0545$					
1.550	Purple-red	*Yellow*	*Rhomboclase*	Sul.	+	Sm.	Y=Z. X⊥001 cleav.	108
1.721	*Pink*	Br.-yellow	Xenotime	Phos.	+	0°	Tet. Prism. 110 cleav.	138
1.875	*Golden*	**Br.-red**	*Plumbojarosite*	Sul.	−	Sm.	Y=? $10\bar{1}1$ cleav. G.=3.67	115
1.905	*Yellow*	*Pink*	**Titanite** †	Sil.	+	28°	Y=*gr.-pink*. Y=*b*	204
2.18	*Orange*	**Red**	*Hewettite*	Van.	−	Mod.	Y=X. Z ‖ elong.	160
2.20	Yellow	Orange-red	*Lepidocrocite*	FeO(OH)	+	83°	Y=orange. X⊥010 cl.	48
2.354	Yellow	Br.-red	Vanadinite	Phos.	−	0°	Hex. Prism. G.=7.0	131
2.59	Orange-red	*Gold-yellow*	Realgar	AsS	−	40°	Y=Z. Y⊥010 cl. X∧*c*=11°	22

VII. Brown Minerals, Not Pleochroic and Isotropic

N	Color	Mineral	Chem.	Cleav.	Other Characters	Page
1.434	Purple, brown, etc.	Fluorite	CaF_2	111	G.=3.18. Sol. H_2SO_4	31
1.49±	Blue, brown	Noselite	Sil.	110 poor	G.=2.3. Gel. HCl	290
1.5±	Golden brown	*Hisingerite*	Sil.	None	G.=3. Dec. HCl	415

1.50±	Blue, brown	Hauynite	Sil.	110 poor	G.=2.4. Gel. HCl	290
1.54±	Brown	*Neotocite*	Sil.	None	G.=2.7. Coal-like	298
1.54±	Green, brown	*Cornuite*	Sil.	None	G.=2±. Conch. frac.	413
1.635±	Reddish brown	*Pitticite*	Sul.	None	G.=2.4±. Sol. HCl	121
1.652	Green, brown	*Greenalite* ‡	Sil.	None	G.=2.8+. Sol. HCl	413
1.7±	Brown, yellow	*Thorite*	Ox.	?	G.=5.3. Also aniso.	185
1.70±	*Red, brown*	**Pyrope**	Sil.	None	G.=3.5. No cleav.	178
1.70	Clear brown	*Polycrase*	Colum.	None	G.=5.0. Dec. H_2SO_4	167
1.73±	Red, brown, etc.	Spinel	$MgAl_2O_4$	111 poor	G.=3.6. Oct.	61
1.74±	Yellowish brown	Caryocerite	Sil.	None	G.=4.3. Dec. HCl	420
1.75±	Yellow, brown	*Tritomite*	Sil.	Poor	G.=4.2. Gel. HCl	420
1.75±	*Brown*	**Grossularite**	Sil.	None	G.=3.5. No cleav.	180
1.8±	Brown	*Manganspinel*	$MnAl_2O_4$	None	G.=4. Oct.	62
1.81±	Brown	*Gahnite*	$ZnAl_2O_4$	111 poor	G.=4.5. Oct.	63
1.82±	*Brown, red*	**Almandite**	Sil.	None	G.=4±. No cleav.	178
1.87±	Red, brown	**Andradite**	Sil.	None	G.=3.7. No cleav.	180
1.9±	Red-brown	*Chevkinite*	Sil.	None	G.=4.4 Gel. HCl	423
2.0±	Brown, yellow	*Pyrochlore*	Tit.	111	G.=4.3. Color zonal	163
2.0±	Brownish	**Limonite** ‡	Ox.	None	G.=3.8. Sol. HCl	47
2.0±	Brown	*Wiikite*	Colum.	?	G.=4.3±. H.=6	167
2.05	Red-brown	*Risoerite*	Tant.	?	G.=4.2. Sol. H_2SO_4	165
2.13	**Brown**	*Ampangabéite* ‡	Colum.	?	G.=4.1±. H.=4	166
2.14	**Brown-black**	*Blomstrandinite* *	Tit.	010 poor	G.=4.9. H.=5.5	167
2.15±	**Brown**	*Samarskite* ‡	Colum.	010 poor	G.=5.7. Insol.	166
2.15±	Red-brown	*Euxenite*	Tit.	None	G.=4.8. Insol.	167
2.15±	Brown	*Fergusonite*	Colum.	111 poor	G.=5.8. Also biref.	164
2.15	Red-brown	*Yttrotantalite*	Tant.	010 poor	G.=5.7. Insol.	166

* Usually pleochroic, greenish to golden yellow in sections of standard thickness.

† Usually colorless in sections of standard thickness (.02–.03 mm.); pleochroic in thicker sections.

‡ Usually opaque in standard sections; colored in extremely thin sections.

TABLE III.—COLOR OF MINERALS

VII. Brown Minerals, Not Pleochroic and Isotropic—*continued*

N	Color	Mineral	Chem.	Cleav.	Other Characters	Page
2.19	Reddish brown	*Zirkelite*	Ox.	None	G.=4.72. Oct.	164
2.20	Red-brown	*Thorianite*	(Th, U)O_2	?	G.=9.3. Radioactive	50
2.215	**Brown**	*Polymignite*	Tit.	100 poor	G.=4.8. Insol.	167
2.23±	Red-brown	*Eschynite*	Colum.	?	G.=5±. Insol.	167
2.30	Brownish	*Knopite*	Tit.	?	G.=4.2. Also biref.	163
2.33	Brown	*Dysanalite* *	Tit.	100	G.=4.13. Dec. HCl	163
2.38	Brown, gray, etc.	Perovskite	$CaTiO_3$	100 poor	G.=4. Also biref.	163
2.4±	Brown, reddish	Sphalerite	ZnS	110	G.=4.1. Sol. HCl	19
Very high	Brown	*Blomstrandite* *	Tit.	?	G.=4.2. H.=5.5	167

VIII. Brown Minerals, Not Pleochroic, But Anisotropic

N_o or N_m	Color	Mineral	Chem.	±	2V	Other Characters	Page
		(a) Birefringence very weak to moderate: $N_g - N_p < 0.0185$					
1.65±	Brown, red	*Hellandite*	Sil.	+	80°	$X=b$. $Z \wedge c = 44°$	425
1.75±	*Brown, yellow*, etc.	**Grossularite**	Sil.	±	Var.	No cleav. G.=3.5	180
1.78±	Green, brown	*Gadolinite*	Sil.	+	85°	No cleav. $Z \wedge c = 10° \pm$	424
1.87±	Red, brown	**Andradite**	Sil.	±	Var.	No cleav. G.=3.7	180
		(b) Birefringence rather strong to strong: $N_g - N_p > 0.0185 < 0.0365$					
1.58±	Brown	*Canbyite*	Sil.	−	Sm.	Z⊥cleav.	415
1.65	Yellow-brown	*Ferrisymplesite*	Arsen.	?	?	Fibrous. G.=2.89	126

1.733	Brown, yellow	*Hematolite*	Arsen.	−	0°	0001 cleav. G.=3.4	153
1.780	Nut brown	*Caryinite*	Arsen.	+	41°	110, 010 cleav. X=*c*	122
2.36±	Brown, yellow	*Wurtzite*	ZnS	+	0°	10$\bar{1}$0 cleav. G.=4±	20

(c) Birefringence very strong: $N_g - N_p > 0.0365 < 0.0545$

1.87	**Red-brown**	*Synadelphite*	Arsen.	+	Sm.	X∧*c*=45°. Z=*b*	155
1.95±	*Brown*, etc.	**Zircon**	Ox.	+	0°	Tet. Prism. G.=4.7	183

(d) Birefringence extreme: $N_g - N_p > 0.0545$

1.88	Red-brown	*Hemafibrite*	Arsen.	+	35°	X⊥010 cleav. Y=*a*	136
2.4±	Brown	*Stibiotantalite*	Tant.	+	75°	X⊥100 cleav. Z=*c*	167
2.45	**Brown**	*Derbylite*	Tit.	+	0°	Twin. G.=4.5	162
2.46	**Red-brown**	*Hausmannite* †	Ox.	−	0°	001 cleav. G.=4.8	64

IX. Brown Minerals, Pleochroic in Brown

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
			(a) Birefringence very weak to weak: $N_g - N_p < 0.0095$					
1.55±	Brown	Clear brown	**Cordierite** ‡	Sil.	−	60°±	Y=**brown.** Ps. Hex. twin.	307
1.64±	Brown	*Brown*	**Apatite** ‡	Phos.	−	0°	Hex. Prism. G.=3.2	129
1.80±	Red-brown	**Brown**	Enigmatite	Sil.	+	32°	Y=brown. Z∧*c*=45°±	428
2.40 Li	Red-brown	Colorless±	*Minium*	Pb_3O_4	?	0°	Abn. int. colors	65
			(b) Birefringence moderate to rather strong: $N_g - N_p > 0.0095 < 0.0275$					
1.58±	Colorless	*Brown*	Vermiculite	Sil.	−	Sm.	Y=Z. X⊥001 cl. G.=2.4	434
1.64	Colorless±	*Brownish*	*Bementite*	Sil.	−	0°±	Y=Z. X⊥001 cleav.	409

* Usually opaque in standard sections; colored in extremely thin sections.

† Usually opaque in sections of standard thickness (.02–.03 mm.); colored in extremely thin flakes or on thin edges.

‡ Usually colorless in standard sections; may be colored in thicker sections.

TABLE III.—COLOR OF MINERALS

IX. Brown Minerals, Pleochroic in Brown—*continued*

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
(b) Birefringence moderate to rather strong: $N_g-N_p>0.0095<0.0275$—*continued*								
1.67±	Clear brown	*Green*	**HORNBLENDE**	Sil.	−	80°	Y = *brown*. $Z\wedge c=20°\pm$	247
1.67±	Red-brown	*Red-brown*	*Triplite*	Phos.	+	Lg.	Y = colorless. $Z\wedge a=42°$	134
1.685	Gr.-brown	Colorless	Dumortierite	Sil.	−	30°	Y = Z. Z⊥100 cleav. X = *c*	422
1.69±	Brownish	**Brown**	Barkevikite	Sil.	−	40°±	Y = red-brown. $Z\wedge c=12°$	254
1.7±	Brown	Red-brown	*Rhoenite*	Sil.	−	?	Y = Z. $Z\wedge c=40°$. 110 cl.	429
1.725	Yel.-brown	Colorless	*Ganophyllite*	Sil.	−	Sm.	Y = Z. 001 cleav. Z = *b*	436
1.788	Colorless	Red-brown	*Retzianite*	Arsen.	+	Lg.	Y = *yel.-brown*. Z = *a*	154
1.809	Yel.-brown	Brown	*Warwickite*	Bor.	+	59°	Y = red-brown. X = *c*	95
1.9±	Colorless	**Brown**	*Chevkinite*	Sil.	±	Var.	Y = *brown*. No cl.	423
(c) Birefringence strong to very strong: $N_g-N_p>0.0275<0.0545$								
1.535	Colorless	Brown	*Quetenite*	Sul.	+	34°	Y = X. 110 cleav. G. = 2.12	116
1.6±	Colorless	Brown	**Fe-muscovite**	Sil.	−	Sm.	Y = Z. X⊥001 cleav.	268
1.60±	Colorless	Brown	Leverrierite *	Sil.	−	Sm.	Y = **brown**. X⊥001 cleav.	433
1.62±	Red-brown	*Brown*	Chondrodite	Sil.	+	Lg.	Y = X. $X\wedge a=28°$. Z = *b*	196
1.7±	Red-brown: X<Y<Z		Iddingsite	Sil.	±	Var.	X⊥100 cl. Z⊥001 cl.	437
1.70±	Colorless	*Brownish*	Grunerite	Sil.	−	82°	Y = X. Y = *b*. $Z\wedge c=12°\pm$	242
1.73	Colorless	Brown	*Pyrochroite*	$Mn(OH)_2$	−	0°	0001 cleav. G. = 3.26	42
1.74	**Yel.-brown**	**Red-brown**	*Melanovanadite*	Van.	−	Sm.	Y = Z. X⊥010 cleav.	102
1.75+	*Red-brown*	Red-brown	*Fourmarierite*	Ox.	−	Lg.	X⊥100 cleav. Z = *b*	103
1.77	**Brown**	*Yel.-brown*	**Acmite**	Sil.	−	60°	Y = brown. $X\wedge c=5°\pm$	234
1.79	Red-brown	Red-brown	Monazite	Phos.	+	12°	Y = **red-brown**	138
1.85±	*Yel.-brown*	**Brown**	*Högbomite*	Ox.	−	0°	No cleav. G. = 3.81	65

1.95	**Red-brown**	Opaque±	*Manganostibite*	Antim.	−	Sm.	Y=Z. X⊥010 cleav.	155
2.36	**Red-brown**: X<Z		*Langbanite*	Ox.?	−	0°	Hex. No cleav. G.=4.7±	66
2.39	**Red-brown**: X<Y>Z		*Pseudobrookite*	Ox.?	+	50°	Y⊥001 cleav. G.=4.6±	165

(d) Birefringence extreme: $N_g - N_p > 0.0545$

1.571	*Brown*	*Brown*	*Roemerite*	Sul.	−	51°	Y=brown. G.=2.15	117
1.637	Colorless	**Gr.-brown**	*Ekmannite*	Sil.	−	0°±	Y=Z. X⊥001 cleav.	281
1.703	Red-brown	*Yel-brown*	*Astrophyllite*	Sil.	+	75°	Y=yel.-brown. X⊥010 cl.	417
1.72	*Yel. brown*	Gray-brown	Xenotime	Phos.	+	0°	Tet. 110 cleav. G.=4.6	138
1.73±	*Brown*	**Brown**	**OXYHORNBLENDE**	Sil.	−	Lg.	Y=Z. Y=*b*. Z∧*c*=1°±	252
1.898	Colorless±	**Red-brown**	*Mazapilite*	Arsen.	−	0°±	Orth. Prism. X=*c*. G.=3.6	156
2.05	Red-brown: Y>X>Z		*Pinakiolite*	Bor.	−	32°	X⊥010 cleav. Y=*c*	94
2.17	Colorless	**Red-brown**	*Melanotekite*	Sil.	+	67°	Y=*red-brown*. 2 cleav.	427
2.20	Red-brown: X<Y<Z		*Kentrolite*	Sil.	+	88°	X=*a*. Z=*c*. 110 cleav.	427
2.2±	Yel. brown	**Brown**	Huebnerite	Tung.	+	Lg.	Y=brown. X⊥010 cl.	101
2.27	Brown	Opaque±	*Tapiolite*	Tant.	+	0°	Tet. Prism. No cleav.	164
2.3	Colorless	Red-brown	*Cuprodescloizite*	Van.	−	60°±	No cleav. X ‖ fib.	133
2.30	Yel.-brown	Opaque±	*Hjelmite*	Tant.	+	0°±	Y=X. Orth. G.=5.8	166
2.34	Red-brown: X>Z weak		*Heterolite*	Ox.	−	0°	Tet. 001 cleav. G.=4.9	65
2.36	Colorless±	Red-brown	*Brackebuschite*	Van.	+	Lg.	Y=Z. Prism. Mono.?	125
2.4±	**Red-brown**	Opaque±	Columbite †	Colum.	−?	Lg.	100 cleav. G.=5.2±	165
2.56	*Brown*	Brown	*Octahedrite*	TiO_2	−	0°	001, 111 cleav. G.=3.9	53
2.59	Cin. brown	Clove brown	*Brookite*	TiO_2	+	Var.	Y=Z. Poor cleav. Z=*a*	59

X. Minerals Pleochroic in Brown and Red

(a) Birefringence very weak to moderate: $N_g - N_p > 0.0185$

1.654	Colorless	Red-brown	*Hureaulite*	Phos.	−	74°	Y=rose. Z∧*c*=75°. X=*b*	124
1.70±	Red	Green	**HYPERSTHENE**	Sil.	−	70°±	Y=yel.-brown. X=*a*	219

* Usually colorless in standard sections; may be colored in thicker sections.

† Usually opaque in standard sections; may be colored in extremely thin portions.

TABLE III.—COLOR OF MINERALS

X. Minerals Pleochroic in Brown and Red—*continued*

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
(b) Birefringence rather strong to very strong: $N_g - N_p > 0.0185 < 0.0545$								
1.57±	Reddish	Brown	**Zinnwaldite**	Sil.	−	Sm.	Y=Z. X⊥001 cleav.	270
1.734	Rose	Yellow	*Adamite*	Arsen.	+	83°	Y=brown. X=*a*. Z=*b*	133
1.81	X or Z=rose		*Hancockite*	Sil.	−	50°	Y=yel.-brown. 001 cl.	316
1.89±	Red-brown	**Red**	*Heterosite*	Phos.	−	Lg.	Y=carmine. X⊥001 cl.	141
(c) Birefringence extreme: $N_g - N_p > 0.0545$								
1.774	Flesh red	**Brown**	*Taramellite*	Sil.	+	40°	Y=X. Z ∥ fib. G.=3.9	427
1.997	*Brown*	**Red**	Cassiterite	SnO_2	+	0°	Tet. Prism. G.=7±	52
2.2	Red	**Blood red**	Huebnerite	Tung.	+	Lg.	X=brown. X⊥010 cl.	101

XI. Red Minerals, Not Pleochroic and Isotropic

N	Color	Mineral	Chem.	Cleav.	Other Characters	Page
1.485	Yellow, pink	**Sodalite**	Sil.	110 poor	G.=2.3. Gel. HCl	289
1.49±	Blue, pink, etc.	Noselite	Sil.	110 poor	G.=2.3. Gel. HCl	290
1.50±	Blue, pink, etc.	Hauynite	Sil.	110 poor	G.=2.4. Gel. HCl	290
1.72±	*Red, brown*	**Pyrope**	Sil.	None	G.=3.6±. Insol.	178
1.73±	Red, blue, etc.	Spinel	$MgAl_2O_4$	111 poor	G.=3.6. Oct.	62
1.737	Pink	*Danalite*	Sil.	111 poor	G.=3.43. Gel. HCl	291
1.74±	Pink	*Tritomite*	Sil.	Poor	G.=4.2. Dec. HCl	420
1.80±	Pink, etc.	**Spessartite**	Sil.	None	G.=4.2.± Insol.	178

1.82±	*Red, brown*	**Almandite**	Sil.	None	G.=4.2±. Insol.	178
1.89±	Red, brown	**Andradite**	Sil.	None	G.=3.75±. Insol.	180
2.13	**Brown-red**	*Ampangabéite* *	Colum.	?	Prism. G.=4.2	166
2.15±	Red	*Koppite*	Tant.	?	Dodec. G.=4.5	164
2.35 Li	**Red**	*Magnesioferrite*	$MgFe_2O_4$	None	G.=4.6. Oct.	61
2.38	Gray, brown, etc.	Perovskite	$CaTiO_3$	100 poor	G.=4. Also biref.	163
2.4±	Brown, red	Sphalerite	ZnS	110 perf.	G.=4.1. Sol. HCl	19
2.69 Li	**Red**	*Hauerite*	MnS_2	100 poor	G.=3.46. Sol. HCl	24
2.72 Li	Bright red	Tetrahedrite	Cu, Sb, S	None	G.=5±. Luster!	26
2.849	Cochineal red	Cuprite	Cu_2O	111 poor	G.=6±. Sol. H_2SO_4	40

XII. Red Minerals, Not Pleochroic, But Anisotropic

N_o or N_m	Color	Mineral	Chem.	±	2V	Other Characters	Page
		(a) Birefringence very weak to moderate: $N_g - N_p < 0.0185$					
1.65±	Brown, red	*Hellandite*	Sil.	+	80°	X=*b*; Z∧*c*=44°	425
1.794	Blood red	*Arseniopleite*	Arsen.	+	0°	$10\bar{1}1$ cleav. Sol. HCl	153
1.89	Red, brown	**Andradite**	Sil.	±	Var.	No cleav. G.=3.75	180
2.38	Gray, red, etc.	Perovskite	$CaTiO_3$	+	90°±	X=*c*. Y=*b*. Poor cleav.	163
		(b) Birefringence rather strong to very strong: $N_g - N_p > 0.0185 < 0.0545$					
1.508	(Violet±) Red	*Ussingite*	Sil.	+	39°	Z∧⊥001=33°±	439
1.8±	Red	*Glockerite*	Sul.	?	?	Fibrous	108
2.008	**Red**	Zincite	ZnO	+	0°	0001 cleav. G.=5.6	41

* Usually opaque in sections of standard thickness (.02–.03 mm.); colored in extremely thin sections.

TABLE III.—COLOR OF MINERALS

XII. Red Minerals, Not Pleochroic, But Anisotropic—*continued*

N_o or N_m	Color	Mineral	Chem.	±	2V	Other Characters	Page
		(c) Birefringence extreme: $N_g - N_p > 0.0545$					
1.683	*Pink*	*Koettigite*	Arsen.	+	77°	X⊥010 cl. $Z \wedge c = 37°$	127
1.997	*Red, brown,* etc.	Cassiterite	SnO_2	+	0°	Tet. Prism. G.=7±	52
2.31	**Red-purple**	*Geikielite*	$MgTiO_3$	−	0°	$10\bar{1}1$ cleav. G.=3.9	67
2.44	Yellow-red	*Pyrophanite*	$MnTiO_3$	−	0°	$02\bar{2}1$ cleav. G.=4.5	67
2.58	Vermilion	*Smithite*	$AgAsS_2$	−	Mod.	100 cleav. $Y = b$	27
2.6±	Orange-red	*Hydrohematite*	Ox.	−	0°?	Fibrous. G.=4.5–5	45
2.6±	Brown-red	**Rutile** *	TiO_2	+	0°	Tet. Prism. G.=4.2	50
2.65	Yellowish red	*Lithargite*	PbO	−	0°	Tet. 110 cleav. G.=9.1	41
>2.72	**Red**	*Lorandite*	$TlAsS_2$	+	Lg.	Z ǁ 100 and 001 cl.	28
>2.72	**Red**	*Miargyrite* *	$AgSbS_2$	+	Mod.	Poor cleav. G.=5.2	27
2.91	Bright red	Cinnabar	HgS	+	0°	$10\bar{1}0$ cleav. G.=8.2	21
3.0±	Cherry red	*Polybasite*	Ag, Sb, S	−	22°	$X = c$. $Z = b$. G.=6.1	27
3.084	**Red**	Pyrargyrite	Ag_3SbS_3	−	0°	$10\bar{1}1$ cleav. G.=5.8	27
3.176	Scarlet	*Hutchinsonite*	Tl, As, S	−	38°	$X = b$. Y⊥100 cleav.	28
3.22	Blood red	**HEMATITE** *	Fe_2O_3	−	0°	0001 part. G.=5.2	44

XIII. Red Minerals, Pleochroic in Red

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
			(a) Birefringence very weak to weak: $N_g - N_p < 0.0095$					
1.58±	*Pink*	Colorless	Beryl †	Sil.	−	0°	Hex. Prism. Poor cleav.	212
1.59±	*Purple*	Red-purple	*Kaemmererite*	Sil.	−	Sm.	Y=Z. X⊥001 cleav.	286

1.60±	Colorless	Pink	Delessite	Sil.	−	Sm.	Y=Z. X⊥001 cleav.	282
1.621	**Rose-red**	*Pink*	*Gillespite*	Sil.	−	0°	0001 cleav. G.=3.33	401
1.72	*Pink*	Colorless	Vesuvianite	Sil.	−	0°	Tet. Poor 110 cleav.	207
1.77	Colorless±	Red	*Ruby*	Al_2O_3	−	0°	0001 part. H.=9. G.=4	43
1.81±	Colorless±	*Reddish*	*Cerite* †	Sil.	+	25°	Y=? No cleav. G.=4.9	422
			(b) Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$					
1.565	Colorless	Yel.-red	*Pyroaurite*	Carb.	−	0°	0001 cleav. Sol. HCl	87
1.62	*Br.-yellow*	*Violet pink*	Topaz †	Sil.	+	60°±	Y=*yel.-pink*. Z⊥001 cl.	198
1.64	*Pink*	Colorless	**Andalusite** †	Sil.	−	84°	Y=Z. X=*c*. Z=*a*. 110 cl.	201
1.65	Colorless	*Pink*	Mullite	Sil.	+	50°	Y=X. Y⊥010 cl. Z=*c*	201
1.725	*Rose-red*	Colorless	*Roselite*	Arsen.	+	Mod.	X⊥100 cleav.± G.=3.5	127
2.62	Blood-red: X<Z		*Arizonite* *	Ox.	?	Mod.	G.=4.2. Dec. H_2SO_4	68
			(c) Birefringence rather strong to strong: $N_g - N_p > 0.0185 < 0.0365$					
1.57±	Colorless	*Pink*	**Lepidolite** †	Sil.	−	50°	Y=Z. X⊥001 cleav.	270
1.64	*Red*	**Red**	**BIOTITE**	Sil.	−	Sm.	Y=Z. X⊥001 cleav.	272
1.73	Colorless	*Pink*	*Strengite*	Phos.	±	Sm.	Y=X. Z⊥001 cleav.	140
1.735	Red	*Red*	*Sicklerite*	Phos.	−	Lg.	Y=red. Z⊥cleav.	158
1.775	*Pink* (‖ cl.) to colorless		*Leucophenicite*	Sil.	−	74°	X⊥cleav. G.=3.85	412
2.16	*Pink*: X<Z		*Bellite* †	Arsen.	−	0°	Hex. needles. G.=5.5	119
			(d) Birefringence very strong: $N_g - N_p > 0.0365 < 0.0545$					
1.59±	Purple-red	Purple-red	*Alurgite*	Sil.	−	0°±	Y=br.-red. X⊥001 cl.	‡
1.723	Colorless	Yel.-red	*Pyrochroite*	$Mn(OH)_2$	−	0°	0001 cleav. Sol. HCl	42
1.73	*Pink*	Colorless±	*Phosphosiderite* †	Phos.	−	62°	Y=carmine. Y⊥010 cl.	142

* Usually opaque in sections of standard thickness (.02-.03 mm.); colored in extremely thin flakes.
† Usually colorless in sections of standard thickness (.02-.03 mm.); colored in thicker sections.
‡ S. L. Penfield: *Am. Jour. Sci.*, XLVI, 1893, p. 288.

TABLE III.—COLOR OF MINERALS

XIII. Red Minerals, Pleochroic in Red—*continued*

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
			(d). Birefringence very strong: $N_g-N_p>0.0365<0.0545$—*continued*					
1.734	Carmine	Colorless±	*Adamite*	Arsen.	−	90°±	X=*a*. Y=*c*. G.=4.35	133
1.75	Br.-red: X<Y<Z		Iddingsite	Sil.	±	Var.	X⊥100 cl. Z⊥001 cl.	437
1.786	*Pink*±	Red	*Beraunite*	Phos.	+	Mod.	Y=X. X∧*c*=89°. Z=*b*	144
1.9±	**Br.-gray**	Red	*Purpurite*	Phos.	+	38°	Y=Z. X⊥001 cl. Z=*b*	141
			(e) Birefringence extreme: $N_g-N_p>0.0545$					
1.898	Colorless±	**Br.-red**	*Mazapilite*	Arsen.	−	0°±	Y=Z. Orth. Prism. X=*c*	156
2.25	*Red*	**Red**	*Mangantantalite*	Tant.	+	Lg.	Y=blood red. G.=5	165
2.59	Orange-red	Vermilion	Realgar	AsS	−	40°	Y=Z. X∧*c*=11°. Y=*b*	22
2.6±	Colorless±	*Red*	*Trechmannite*	$AgAsS_2$	−	0°	$10\bar{1}1$, 0001 cleav.	27
2.6±	Br.-red	Blood red	**Rutile** *	TiO_2	+	0°	Tet. Prism. G.=4.2	50
>2.72	Red: X>Y>Z		*Kermesite*	Sb_2S_2O	+	Sm.	100, 101 cleav. G.=4.5	28
>2.72	**Deep red**	Opaque±	*Chalcophanite*	Ox.	−	0°	0001 cleav. G.=3.91	66
3.0±	Red: X>Z		Livingstonite	$HgSb_4S_7$	−	?	Prism. cleav. Z=*c*	28
3.087	Red	Blood red	Proustite	Ag_3AsS_3	−	0°	$10\bar{1}1$ cleav. G.=5.6	27
3.22	Yel.-red	Br.-red	**HEMATITE** *	Fe_2O_3	−	0°	Hex. 0001 part. G.=5.2	44

XIV. Minerals Pleochroic in Red and Blue

(a) Birefringence very weak to moderate: $N_g-N_p>0.0185$

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
1.55±	*Reddish*	*Clear blue*	**Cordierite** †	Sil.	−	60°±	Y=*violet*. Ps. Hex. twin.	307
1.665	*Purple*	Colorless	*Kunzite*	Sil.	+	69°	Y=*pink*. Z∧*c*=25°	236
1.685	Blue	Colorless	Dumortierite	Sil.	−	30°±	Y=red. Z⊥100 cleav.	422
1.69	Red-gray	Gr. blue	*Kataphorite*	Sil.	−	35°±	Y=br.-red. Z∧*c*=45°±	254
1.70±	Red	*Blue*	**HYPERSTHENE**	Sil.	−	70°±	Y=yellow. X=*a*. Z=*c*	219

(b) Birefringence rather strong to strong: $N_g - N_p > 0.0185 < 0.0365$

1.70±	Reddish	Violet	**AUGITE (Ti)**	Sil.	−	60°	Y=Z. Y=*b*. Z∧*c*=45°±	228
1.79±	*Br.-red*	*Gr.-blue*	Tephroite †	Sil.	−	65°	Y=*red*. X⊥010 cleav.	194
1.87±	Br.-red	**Violet**	*Heterosite*	Phos.	−	Lg.	Y=carmine. X⊥001 cl.	141
2.146	Violet red	Violet red	*Rafaelite*	Hal.	?	?	Y=**violet.** 001 cleav.	39

(c) Birefringence very strong to extreme: $N_g - N_p > 0.0365$

1.663	*Pinkish*	Red	Erythrite	Arsen.	±	90°±	Y=*violet*. X⊥010 cl.	127
1.734	Magenta	Rose	*Adamite*	Arsen.	±	83°	Y=purple. X=*a*. Z=*b*	133
1.75±	*Greenish*	Pink	**EPIDOTE** ‡	Sil.	−	70°±	Y=*blue*. Z∧001 cl.=25°	314
1.75±	Yellow	Red	*Piedmontite*	Sil.	+	70°±	Y=blue. Z∧001 cl.=32°	315

XV. Minerals Pleochroic in Brown and Blue

(a) Birefringence very weak to moderate: $N_g - N_p < 0.0185$

1.685	*Brown*	*Yellow*	**Axinite** †	Sil.	−	73°	Y=*violet*. X⊥011±	425
1.69±	Red-gray	Gr.-blue	*Kataphorite*	Sil.	−	35°±	Y=gr.-brown. Z∧*c*=45°±	254
1.695	**Blue**	Brown	**Riebeckite**	Sil.	−	Lg.	Y=blue. X∧*c*=3°±. Z=*b*	257
1.72±	*Brown*	Blue	*Sapphirine* †	Sil.	−	69°	Y=Z. Y=*b*. Z∧*c*=10°±	427
1.73±	Br.-green±	Gr.-brown	Chloritoid	Sil.	+	50°±	Y=**blue.** 001 cleav.	438

(b) Birefringence very strong to extreme: $N_g - N_p > 0.0365$

1.60	**Blue**	*Brownish*	Vivianite	Phos.	+	Lg.	Y=colorless. X⊥010 cl.	126
1.762	Gr.-blue	*Yel.-brown*	*Dihydrite*	Phos.	±	90°±	Y=yel.-green. Z ‖ fib.±	135

* Usually opaque in standard sections; colored in extremely thin portions.

† Usually colorless in sections of standard thickness (.02–.03 mm.); colored in thicker sections.

‡ Usually yellowish green to golden in thin section.

TABLE III.—COLOR OF MINERALS

XVI. Blue Minerals, Not Pleochroic and Isotropic

N	Color	Mineral	Chem.	Cleav.	Other Characters	Page
1.434	Blue, purple, etc.	Fluorite	CaF_2	111 perf.	Colored in spots	31
1.435	Violet	*Yttrocerite*	Hal.	111 perf.	Colored in spots	36
1.485±	Yellow, blue, pink	**Sodalite**	Sil.	110 poor	G.=2.3. Gel. HCl	289
1.49±	Blue, yellow, etc.	Noselite	Sil.	110 poor	G.=2.3. Gel. HCl	290
1.50±	Blue	Lazurite	Sil.	110 poor	G.=2.4. Gel. HCl	290
1.54±	Blue-green, blue	*Cornuite*	Sil.	None	G.=2±. Opaline	413
1.73±	Red, blue, etc.	Spinel	$MgAl_2O_4$	111 poor	H.=8. G.=3.6	62
1.81±	Green, blue, etc.	*Gahnite*	$ZnAl_2O_4$	111 fair	G.=4.5. Oct.	63
2.05	Sky-blue	*Percylite*	Hal.	100	Sol. HNO_3	37

XVII. Blue Minerals, Not Pleochroic But Anisotropic

N_o or N_m	Color	Mineral	Chem.	±	2V	Other Characters	Page
		(a) Birefringence very weak to very strong: $N_g - N_p < 0.0545$					
1.434	Blue, purple, etc.	Fluorite *	CaF_2	?	?	111 cleav. G.=3.2	31
1.73±	Gr.-blue	*Connellite*	Sul.	+	0°	Hex. Acic. G.=3.4	118
1.731	*Gr.-blue*	*Chalcomenite*	Sel.	−	Var.	Mon. Y=*b*. G.=3.76	118
2.03	**Blue**	*Pseudoboléite*	Hal.	−	0°	001, 101 cleav. G.=4.9	37
2.06	Gr.-blue	*Boléite*	Hal.	−	0°	001, 101 cleav. G.=5	37
		(b) Birefringence extreme: $N_g - N_p > 0.0545$					
1.658	*Gr.-blue*	*Veszelyite*	Phos.	+	71°	No cleav. G.=3.5	138
1.8±	Gr.-blue	*Cornetite*	Phos.	−	33°	X=*a*. Z=*b*. G.=4.1	132

XVIII. Blue Minerals Pleochroic in Blue

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
			(a) Birefringence very weak to weak: $N_g-N_p<0.0095$					
1.58	*Blue*	*Bluish*±	Beryl †	Sil.	−	0°	Hex. Prism. G.=2.75±	212
1.6±	Colorless	**Blue**	*Aerinite*	Sil.	−	Sm.	Y=Z. $X\perp 001$ cleav.	285
1.634	*Blue*: X>Z or X<Z		**Apatite** †	Phos.	−	0°	Hex. Prism. G.=3.2	129
1.66±	Colorless	**Violet**	*Crossite*	Sil.	−	Sm.	Y=blue. $X\wedge c=70°\pm$	259
1.71±	Colorless	**Blue**	Vesuvianite †	Sil.	−	0°	Tet. Poor 110 cleav.	207
1.72±	Colorless	**Blue**	***Sapphirine***	Sil.	−	69°	Y=Z. Y=*b*. $Z\wedge c=10°\pm$	427
1.769	*Bluish*	*Blue*	*Sapphire*	Al_2O_3	−	0°	Hex. H.=9. G.=4±	43
			(b) Birefringence moderate: $N_g-N_p>0.0095<0.0185$					
1.555	Colorless	Colorless	*Vauxite*	Phos.	+	Sm.	Y=blue. Tric. No cl.	157
1.665	Purple	Colorless	*Kunzite*	Sil.	+	69°	Y=amethystine. $Z\wedge c=25°$	236
1.685	**Blue**	Colorless±	Dumortierite	Sil.	−	30°	Y=Z. X=*c*. $Z\perp 100$ cleav.	422
1.722	Colorless	**Blue**	**Kyanite**	Sil.	−	82°	Y=blue. 100, 010 cleav.	205
			(c) Birefringence rather strong: $N_g-N_p>0.0185<0.0275$					
1.530	**Blue**	Colorless	***Minasragrite***	Sul.	−	Lg.	Y=*blue*. $X\perp 010$ cl.	110
1.542	*Lilac*	Lilac	*Stichtite*	Carb.	−	0°	0001 cleav. G.=2.16	87
1.638	Colorless	**Blue**	Glaucophane	Sil.	−	Mod.	Y=violet. $Z\wedge c=5°\pm$	258
1.65±	Colorless	Blue	**Tourmaline**	Sil.	−	0°	Max. abs.$\perp$elong.	301
			(d) Birefringence strong: $N_g-N_p>0.0275<0.0365$					
1.56	Colorless	*Violet*	**Lepidolite** †	Sil.	−	50°±	Y=Z. $X\perp 001$ cleav.	270
1.632	Colorless	Blue	Lazulite	Phos.	−	69°	Inclusions common	154
1.73	Colorless±	**Blue**	*Strengite*	Phos.	±	Sm.	Y=violet. $Z\perp 001$ cl.	140

* Usually isotropic.

† Usually colorless in standard sections: colored in thicker sections.

TABLE III.—COLOR OF MINERALS

XVIII. Blue Minerals Pleochroic in Blue—*continued*

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
			(e) Birefringence very strong: $N_g-N_p>0.0365<0.0545$					
1.62	Colorless to *blue*		*Turquois*	Phos.	+	40°	Two cleav. G.=2.84	157
1.722	Colorless	Blue	Diaspore	AlO(OH)	+	84°	Y=X. Y⊥010 cleav. Z=*a*	46
1.75	Colorless	Colorless	**EPIDOTE** *	Sil.	−	70°±	Y=*blue*. Z∧001 cl.=25°	314
1.757	Colorless	Blue	*Benitoite*	Sil.	+	0°	Rhom. Color varies	212
1.838	*Blue*	Prus. blue	*Linarite*	Sul.	−	80°	Y=blue. X∧100 cl.=24°	104
2.654	Blue	*Blue*	*Moissanite*	SiC	+	0°	H.=9.5. G.=3.2	17
			(f) Birefringence extreme: $N_g-N_p>0.0545$					
1.617	Colorless	Blue	*Kyanotrichite*	Sul.	+	83°	Y=*blue*. X=*a*. Z=*c*	116
1.660	Colorless	Blue	*Planchéite*	Sil.	+	Mod.	Y=X. X⊥cl. Z ‖ fib.	411
1.748	*Gr.-blue*	Gr.-blue	*Freirinite*	Arsen.	−	0°	001 cleav. Sol. HCl	151
1.758	Clear blue	**Blue**	Azurite	Carb.	+	68°	Y=*b*. Z∧*c* =−13°	82
1.782	*Blue*	**Blue**	*Shattuckite*	Sil.	+	Lg.	Y=*gr.-blue*. Z ‖ fib.±	411
1.866	Blue: X and Z>Y		*Caledonite*	Sul.	−	85°	X⊥100 cl. Z⊥001 cl.	120
2.04	Clear blue	Blue	*Cumengéite*	Hal.	−	0°	101, 110 cleav. G.=4.8	37
2.55	Blue	**Blue**	*Octahedrite*	TiO_2	−	0°	001, 111 cleav. G.=3.9	53

XIX. Minerals Pleochroic in Blue and Green

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
			(a) Birefringence very weak or weak: $N_g-N_p<0.0095$					
1.585	***Bluish***	**Green**	*Metazeunerite*	Arsen.	−	0°	001 cleav. G.=3.28	146
1.624	*Blue*	Green	*Metatorbernite*	Phos.	+	0°±	001 cleav. G.=3.7	145

1.69±	**Blue**	Green	Arfvedsonite	Sil.	−	Lg.	Y=blue. X∧c=Sm.	257
1.695±	**Indigo**	Green	**Riebeckite**	Sil.	−	Lg.	Y=blue. X∧c=3°±	257
1.703	Green	Blue	*Serendibite*	Sil.	+	90°±	Y=X. No cleav. G.=3.4	425
1.769	*Green*	*Blue*	*Sapphire*	Al_2O_3	−	0°	0001 part. H.=9. G.=4±	43
			(b). Birefringence moderate: $N_g-N_p>0.0095<0.0185$					
1.68±	*Yellow±*	*Green±*	**Axinite**	Sil.	−	75°	Y=blue. X⊥011±	425
1.73±	Olive green	*Yellow±*	Chloritoid	Sil.	+	Mod.	Y=blue. 001 cleav.	438
			(c) Birefringence rather strong: $N_g-N_p>0.0185<0.0275$					
1.63±	Gr.-yellow	Gr.-blue	**Pargasite**	Sil.	+	60°±	Y=green. Z∧c=25°±	248
1.655	*Blue*	*Blue*	*Euclase* †	Sil.	+	50°±	Y=*yel.-green.* Y⊥010 cl.	432
1.665	*Yellow*	*Blue*	**Sillimanite** †	Sil.	+	27°±	Y=*green.* Y⊥010 cleav.	200
1.67±	Yellow	Gr.-blue	**HORNBLENDE**	Sil.	−	80°±	Y=bl.-green. Z∧c=20°±	247
1.713	Green	Blue	*Gerhardtite*	Nit.	+	Lg.	Y=green. Z⊥001 cl.	89
			(d) Birefringence very strong: $N_g-N_p>0.365<0.0545$					
1.60±	**Blue**	*Olive green*	Vivianite	Phos.	+	Lg.	Y=colorless. X⊥010 cl.	126
1.75±	Greenish	Pink	**EPIDOTE** *	Sil.	−	70°±	Y=blue. X∧001 cl.=25°	314
2.654	Olive green	Gr.-blue	*Moissanite*	SiC	+	0°	Poor 0001 cleav. H.=9.5	17
			(e) Birefringence extreme: $N_g-N_p>0.0545$					
1.642	*Green*	**Gr.-blue**	*Serpierite*	Sul.	−	35°	Y=Z. X⊥001 cleav.	102
1.668	Blue	Yel.-green	*Symplesite*	Arsen.	−	87°	Y=yellow. X⊥010 cl.	126
1.745	*Bluish*	*Bluish*	*Libethenite*	Phos.	−	83°	Y=yel.-green. X=*b*. Z=*a*	132
1.762	Gr.-blue	*Yel.-brown*	*Dihydrite*	Phos.	±	90°±	Y=yel.-green. Z=*b*±	135

* Usually yellowish green to golden in thin section.

† Usually colorless in standard sections: colored in thicker sections.

TABLE III.—COLOR OF MINERALS

XX. Green Minerals, Not Pleochroic and Isotropic

N	Color	Mineral	Chem.	Cleav.	Other Characters	Page
1.434	Red, green, etc.	Fluorite *	CaF_2	111 perf.	G. = 3.18. Cubic	31
1.50±	Blue, green, etc.	Hauynite	Sil.	110 poor	G. = 2.4. Gel. HCl	290
1.54±	Green, blue, etc.	*Cornuite*	Sil.	None	G. = 2±. Sol. HCl	413
1.585	Green	*Volchonskoite*	Sil.	None	G. = 2.3. Gel. HCl	416
1.59±	**Emerald green**	*Zaratite*	Carb.	None	G. = 2.6. Sol. HCl	85
1.59	Bright green	*Garnierite*	Sil.	None	Fibrous. Dec. HCl	261
1.60±	Oil-green	*Voltaite*	Sul.	?	G. = 2.79. Sol. H_2O	115
1.65	Green, brown, etc.	*Greenalite* †	Sil.	None	G. = 2.8+. Sol. HCl	413
1.725	*Green*	*Rowlandite*	Sil.	None	G. = 4.5. Gel. HCl	420
1.758	*Green*	*Yttrialite*	Sil.	None	G. = 4.58. Sol. HCl	414
1.77±	Green	*Ceylonite*	$MgAl_2O_4$	111 poor	G. = 3.6. Oct.	62
1.77±	Grass-green	*Chlorospinel*	$MgAl_2O_4$	111 poor	G. = 3.6. Oct.	62
1.8±	Green, blue, etc.	*Gahnite*	$ZnAl_2O_4$	111 fair	G. 4.5. Oct.	63
1.87±	Green	*Uvarovite*	Sil.	None	G. = 3.7±. Insol.	263
1.9±	Green	*Hercynite*	$FeAl_2O_4$	?	G. = 3.9. Insol.	62
2.16 Li	**Emerald green**	*Manganosite*	MnO	100	G. = 5.18. Oct.	41
2.23	Green, brown	*Bunsenite*	NiO	?	G. = 6.4. Oct.	41

XXI. Green Minerals, Not Pleochroic, But Anisotropic

N_o or N_m	Color	Mineral	Chem.	±	2V	Other Characters	Page
		(a) Birefringence very weak to weak: $N_g - N_p < 0.0095$					
1.483	*Blue-green*	*Zn-Cu-melanterite*	Sul.	+	Lg.	Y ∧ fib. = Lg. Z = *b*	106
1.556	*Blue-green*	*Miloschite*	Sil.	−	90°±	001 cleav. G. = 2.1	416
1.69	*Green*	*Pharmacosiderite*	Phos.	−	Sm.	Cubic. G. = 3	143

(b) Birefringence rather strong to very strong: $N_g - N_p > 0.0185 < 0.0545$

1.59	Yellow-green	*Connarite*	Sil.	−	0°±	X⊥001 cl. G. = 2.5	280
1.686	*Blue-green*	*Trichalcite*	Arsen.	−	Lg.	X⊥plates. Sol. HCl	124
1.698	Bluish green	*Euchroite*	Arsen.	+	29°	X = *b*. Z ‖ prism.	136
1.77	*Green*	*Conichalcite*	Arsen.	−	25°	X = *c*. Z ‖ *a* = fib.	136
1.774	Yellow-green	*Barthite*	Arsen.	+	Mod.	No cleav. G. = 4.19	160
2.01	*Green*	*Volborthite*	Van.	±	Var.	Bx.⊥cleav. G. = 3.5	137
2.05	Dull green	*Fernandinite*	Van.	?	?	Fibrous. Sol. HCl	148
2.15	Green	*Cuprotungstite*	Tung.	?	?	One cleav. G. = 3.95	105

(c) Birefringence extreme: $N_g - N_p > 0.0545$

1.652	Greenish	*Liroconite*	Arsen.	−	67°	X = *b*. Z∧*c* = −25°	157
1.70	*Green*	*Ancylite*	Carb.	−	66°	No cleav. G. = 3.95	87
1.745	*Green*	*Libethenite*	Phos.	−	83°	X = *b*. Z = *a*. Poor cl.	132
1.745	*Green*	*Mixite*	Arsen.	+	Sm.	Z ‖ fib. G. = 3.8	156
1.90	Bluish green	*Trippkeite*	Arsen.	+	0°	100 cleav. Sol. HCl	159

XXII. Green Minerals Pleochroic in Green

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
(a) Birefringence very weak: $N_g - N_p < 0.0035$								
1.57±	Colorless	*Green*	**Penninite**	Sil.	−	Sm.	Y = Z. X⊥001 cl. G. = 2.7±	281
1.59±	*Green*	Colorless	**Penninite**	Sil.	+	Sm.	Y = X. Z⊥001 cl. G. = 2.8±	281
1.60±	Colorless	*Green*	Delessite	Sil.	−	Sm.	Y = Z. X⊥001 cl. G. = 2.8±	282
1.62±	Colorless	*Green*	Diabantite	Sil.	−	Sm.	Y = Z. X⊥001 cl. G. = 2.8±	283

* Usually colorless or purple in standard sections; may be colored red or green in thicker sections.
† Often opaque in standard sections; colored in extremely thin portions.

TABLE III.—COLOR OF MINERALS

XII. Green Minerals Pleochroic in Green—*continued*

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
			(a) Birefringence very weak: $N_g-N_p<0.0035$—*continued*					
1.62±	*Green*	Colorless±	Ripidolite	Sil.	+	Sm.	Y=X. Z⊥001 cl. G.=2.9±	284
1.64±	Colorless±	Green	Aphrosiderite	Sil.	−	Sm.	Y=Z. X⊥001 cl. G.=2.96	284
1.66±	Colorless±	Green	Daphnite	Sil.	−	Sm.	Y=Z. X⊥001 cl. G.=3.0	285
			(b). Birefringence weak: $N_g-N_p>0.0035<0.0095$					
1.58±	*Green*	*Yel.-green*	Beryl *	Sil.	−	0°	Hex. Prism. G.=2.75±	212
1.58±	*Green*	Colorless±	**Clinochlore**	Sil.	+	Sm.	Y=X. Z⊥001 cl. G.=2.7±	283
1.60±	*Green*	Colorless±	Prochlorite	Sil.	+	Sm.	Y=X. Z⊥001 cl. G.=3.07	284
1.66±	Colorless±	Green	Thuringite	Sil.	−	Sm.	Y=Z. X⊥001 cl. G.=3.07	285
1.69±	**Bl.-green**	Br.-green	Arfvedsonite	Sil.	−	Lg.	Y=X. X∧c=Sm. Z=b	257
2.33	Gray-green: X<Z		*Dysanalite* †	Tit.	+	90°±	Y=? Y=c. Z=b. G.=4.1	163
			(c) Birefringence moderate: $N_g-N_p>0.0095<0.0185$					
1.55±	Colorless	*Green*	**Chrysotile**	Sil.	+	30°	Y=X. Z ‖ fib. G.=2.5	260
1.59±	**Bl.-green**	*Br.-green*	Corundophilite	Sil.	+	Sm.	Y=X. Z⊥001 cl.± G.=2.9±	283
1.6±	*Green*	Colorless	Chrysocolla	Sil.	±	Sm.	Fibrous. G.=2.4±	411
1.63±	*Yel.-green*	**Green**	Celadonite	Sil.	−	Sm.	Y=Z. X⊥001 cleav.	436
1.64±	Colorless±	*Green*	*Chamosite*	Sil.	−	Sm.	Y=Z. X⊥001 cleav.	286
1.662	Olive green: X>Y>Z		*Dickinsonite*	Phos.	+	Mod.	X=b. Y⊥001 cleav.±	122
1.671	Green	Colorless	*Hiddenite*	Sil.	+	56°	Y=greenish. Z∧c=27°	236
1.69±	Green	Colorless	Dumortierite	Sil.	−	30°	Y=X. Z⊥100 cleav.	422
1.700	Colorless	Colorless	*Pumpellyite*	Sil.	+	Lg.	Y=green. X⊥001 cl.	432

1.701	*Yel.-green*	Colorless	*Tinzenite*	Sil.	−	63°	Y = *greenish*. X⊥100 cl.±	428
1.73±	*Greenish*	*Green*	**Clinozoisite**	Sil.	+	85°±	Y = X. Z∧001 cl. = 20°±	312
1.74±	*Green*	**Green**	**Hedenbergite**	Sil.	+	60°	Y = yel.-green. Z∧c = 48°	224
1.78	Olive green	Green	*Gadolinite*	Sil.	+	85°	Y = Z. Y = b. X∧c = 10°±	424
1.84	Yel.-green: X<Z		*Dussertite*	Arsen.	−	0°	Hex. Lam. G. = 3.75. Sol. HCl	153
			(d) Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$					
1.594	Colorless	Green	*Astrolite*	Sil.	−	30°	Y = Z. X⊥cleav. G. = 2.8	429
1.61±	Yel.-green	Olive green	*Nontronite*	Sil.	−	Var.	Y = X. X⊥001 cleav.	415
1.63±	Yel.-green: X<Y=Z		Glauconite †	Sil.	−	Sm.	X⊥001 cleav. G. = 2.5±	436
1.643	*Green:* X<Z		*Zeunerite*	Arsen.	−	0°±	X⊥001 cleav. G. = 3.2	146
1.646	Colorless	*Green*	**Tourmaline**	Sil.	−	0°	Max. abs.⊥elong.	301
1.67±	Yel.-green	**Green**	**HORNBLENDE**	Sil.	−	80°±	Y = olive. X∧c = 20°±	247
1.67±	*Green*	Opaque±	*Strigovite*	Sil.	−	Sm.	Y = Z. X⊥001 cleav.	437
1.68±	Colorless	Gray-green	*Sincosite*	Phos.	−	0°	X⊥001 cleav. G. = 2.8	147
1.786	*Sea green*	Yel.-green	*[illegible]*	Arsen.	−	Sm.	Y = Z. X∧c = 50°. G. = 3.8	155
			(e) Birefringence strong: $N_g - N_p > 0.0275 < 0.0365$					
1.558	Colorless	*Green*	*Metavariscite*	Phos.	+	55°	Y = Z. X = a (elong.). Y = b	141
1.62±	Green	Yel.-green	*Nepouite*	Sil.	−	Sm.	Y = Z. X⊥001 cleav.	279
1.726	Grass green	Grass green	*Tyrolite*	Arsen.	−	36°	Y = yel.-green. X⊥001 cl.	161
1.77±	Colorless	*Bl.-green*	*Conichalcite*	Arsen.	±	25°	Y = *greenish*. Z ∥ fib.	136
1.78±	Colorless	*Green*	**Allanite**	Sil.	−	Lg.	Y = ? G. = 4.1. Gel. HCl	316
1.78±	Colorless	Green	Scorodite ‡	Arsen.	+	62°	Y = ? X = b. Z = c. G. = 3.2	139
			(f) Birefringence very strong: $N_g - N_p > 0.0365 < 0.0545$					
1.595	Colorless	**Bl.-green**	*Fuchsite*	Sil.	−	40°±	Y = yel.-green. X⊥001 cl.	269
1.636	**Bl.-green**	**Green**	*Grandidierite*	Sil.	−	30°	Y = colorless. X⊥100 cl.	421

* Usually colorless in standard sections; colored in thicker sections.

† Usually opaque in standard sections; may be colored in extremely thin portions.

‡ Pleochroic colors transposed on page 138.

TABLE III.—COLOR OF MINERALS

XXII. Green Minerals Pleochroic in Green—*continued*

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
			(f) Birefringence very strong: $N_g-N_p>0.0365<0.0545$—*continued*					
1.657	*Green*: X>Z		*Dioptase* *	Sil.	+	0°	$10\bar{1}1$ cleav. Gel. HCl	186
1.694	Bl. green	Green	*Spangolite*	Sul.	−	0°	0001 cleav. G.=3.14	119
1.697	Colorless	*Greenish*	Grunerite	Sil.	−	80°	Y=X. Y=*b*. Z∧*c*=12°±	242
1.80±	**Green**	Opaque±	Cronstedtite	Sil.	−	Sm.	Y=Z. X⊥001 cleav.	285
1.831	Green	Bl.-green	*Higginsite*	Arsen.	−	90°±	Y=yel.-green. X=*a*. Y=*b*	132
1.86	*Green*	Grass green	*Atacamite*	Hal.	−	75°	Y=yel.-green. X⊥010 cl.	38
			(g) Birefringence extreme: $N_g-N_p>0.0565$					
1.618	*Green*	Bl.-green	*Chalcophyllite*	Arsen.	−	0°	0001 cleav. G.=2.5	136
1.649	*Green*	Bl.-green	*Herrengrundite*	Sul.	−	39°	Y=green. X⊥001 cl.±	104
1.67±	Colorless	*Green*	*Ekmannite*	Sil.	−	Sm.	Y=Z. X⊥001 cl. G.=2.79	281
1.737	*Yel.-green*	Green	*Antlerite*	Sul.	−	35°	Y=Z. X⊥010 cl. G.=3.9	102
1.74±	Colorless±	*Green*	*Aurichalcite*	Carb.	−	Sm.	Y=Z. Y⊥100 cleav.±	84
1.745	*Green*	*Green*	*Libethenite*	Phos.	−	83°	Y=green. X=*b*. Y=*c*	132
1.760	Bl.-green	**Bl.-green**	*Langite*	Sul.	−	81°	Y=yel.-green. X⊥001 cl.	102
1.778	Green: X and Y<Z		*Brochantite*	Sul.	−	72°	X⊥010 cleav. Z=*c*	102
1.840	Colorless	*Green*	*Chalcosiderite*	Phos.	−	24°	Y=? X⊥010 cleav.±	157
1.87	*Bl.-green*	Benzol green	*Clinoclasite*	Arsen.	−	53°	Y=bl.-green. X⊥001 cl.±	135
1.875	Colorless±	**Green**	Malachite	Carb.	−	43°	Y=yel.-green. X∧*c*=23°	85
2.2±	Yel.-green	Grass-green	Huebnerite	Tung.	+	Lg.	Y=*green*. X⊥010 cl.	101

XXIII. Minerals Pleochroic in Green and Yellow

(a) Birefringence very weak to weak: $N_g-N_p<0.0095$

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
1.57±	*Yellow*	*Green*	**Antigorite**	Sil.	−	Sm.	Y=Z. X⊥001 cl. G.=2.6±	280
1.60±	*Yellow*	Green	Delessite	Sil.	−	Sm.	Y=Z. X⊥001 cl. G.=2.8±	282
1.60±	Green	*Gr.-yellow*	Prochlorite	Sil.	+	Sm.	Y=X. Z⊥001 cl. G.=2.85	284

1.655	*Yel.-green*	*Gr.-yellow*	*Uranochalcite*	Sul.	+	Sm.	Y=X. Z ∥ fib. Sol. HCl	117
1.66±	*Yellow*	Green	Daphnite	Sil.	−	Sm.	Y=Z. X⊥001 cl. G.=3.0	381
1.695	**Blue**	Green	Riebeckite	Sil.	−	Lg.	Y=gr.-yellow. $X \wedge c = 3°$	257
1.72±	*Green*	*Gr.-yellow*	Vesuvianite *	Sil.	−	0°	Tet. G.=3.4. Contacts	207
			(b) Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$					
1.545	*Gr.-yellow*	*Green*	**Chrysotile** *	Sil.	+	30°	Y=Z. Z ∥ fib. G.=2.4	260
1.592	*Green*	*Gr.-yellow*	*Torbernite*	Phos.	−	0°±	X⊥001 cleav. G.=3.2	145
1.64±	*Yellow*	*Gr.-yellow*	**Andalusite** *	Sil.	−	84°	Y=green. X ∥ 110 cleav.	201
1.660	Orange	*Green*	*Brandisite*	Sil.	−	57°	Y=Z. X⊥001 cl. G.=3.1	286
1.675	*Red-yellow*	*Green*	*Kornerupine* *	Sil.	−	20°	Y=*yellow*. X ∥ 110 cl.	421
1.681	*Yellow*	*Greenish*	*Prismatine* *	Sil.	−	30°	Y=*br.-yellow*. X=*c*	421
1.685	*Yellow*	*Green*	**Axinite**	Sil.	−	75°	Y=*blue*. X⊥011±	425
1.70±	Red-yellow	Green	**HYPERSTHENE**	Sil.	−	70°±	Y=yellow. X=*a*. Z=*c*	219
1.72±	Olive green	*Yellow*	Chloritoid	Sil.	+	50°±	Y=**blue**. 001 cleav.	438
2.061	*Yellow*	*Green*	Pyromorphite	Phos.	−	0°	Hex. Prism. G.=7.0	131
			(c) Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$					
1.547	**Bl.-green**	*Yellow±*	*Voglite*	Carb.	+	60°	Y=X. X nearly ⊥ scales	88
1.6±	Gr.-yellow	Green	Bowlingite	Sil.	−	Sm.	Y=Z. X⊥001 cleav.±	437
1.62±	*Yellow*	Green	*Nontronite*	Sil.	−	Var.	Y=olive. X⊥001 cl.	415
1.63±	Gr.-yellow	Gr.-blue	**Pargasite**	Sil.	+	60°	Y=**green**. $X \wedge c = 25°\pm$	248
1.63±	*Yellow*	Green	Actinolite	Sil.	−	80°	Y=gr.-yellow. $Z \wedge c = 15°\pm$	245
1.63±	*Yellow*	Green	Glauconite †	Sil.	−	Sm.	Y=Z. X⊥001 cleav.	436
1.66±	*Yellow*	*Blue*	**Sillimanite** *	Sil.	+	30°	Y=*green*. Y⊥010 cl.	200
1.67±	*Yellow*	**Blue, green**	**HORNBLENDE**	Sil.	−	80°	Y=green, yellow. 110 cl.	247
1.680	Colorless±	Green	*Sincosite*	Phos.	−	0°±	X⊥001 cleav. G.=2.8	147
1.725	*Bl.-green*	*Br.-yellow*	*Homilite* *	Sil.	+	80°	Y=*br.-gray*. Y=*c*±	424
1.786	*Sea green*	*Yellow*	*Allactite*	Arsen	−	Sm.	Y=Z. $X \wedge c = 50°\pm$. G.=3.8	155

* Usually colorless in standard sections; colored in thicker sections.

† Usually opaque in standard sections; may be colored in extremely thin portions.

TABLE III.—COLOR OF MINERALS

XXIII. MINERALS PLEOCHROIC IN GREEN AND YELLOW—*continued*

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
			(d) Birefringence strong: $N_g-N_p>0.0275<0.0365$					
1.619	*Br.-yellow*	*Yel.-green*	Chondrodite	Sil.	+	Lg.	Y=Z. $X \wedge a=28° \pm$	196
1.670	*Br.-yellow*	*Yel.-green*	Clinohumite	Sil.	+	76°	Y=Z. $X \wedge a=10° \pm$	197
1.671	Yellow	**Yellow**	*Manganandalusite*	Sil.	+	71°	Y=green. 110 cleav. X=*a*	202
1.69±	Green	*Yellow*	Aegirinaugite	Sil.	+	65°	Y=gr.-yellow. $Z \wedge c=70° \pm$	232
1.77±	*Yellowish*	*Bl.-green*	*Conichalcite*	Arsen.	−?	25°	Y=*greenish*. Z ‖ fib.	136
1.78±	*Yellow*	*Green*	Scorodite	Arsen.	+	62°	Y=? X=*b*. Y=*a*. G.=3.2	139
1.85	Gr.-yellow	Pink	*Törnebohmite*	Sil.	+	26°	Y=bl.-green. G.=4.9	414
1.9±	Br.-yellow	**Green**	Ilvaite	Sil.	−	Sm.	Y=**brown**. Z=*c*	431
			(e) Birefringence very strong: $N_g-N_p>0.0365<0.0545$					
1.63±	Yellow	**Green**	**BIOTITE**	Sil.	−	0°±	Y=Z. X⊥001 cleav.	272
1.687	Yellow	**Green**	**Tourmaline**	Sil.	−	0°	Max. abs.⊥elong.	301
1.70±	*Yellow*	**Blue, green**	**HORNBLENDE**	Sil.	−	80°	Y=green, yellow. 110 cl.	247
1.75±	*Yellow*	Yel.-green	**EPIDOTE**	Sil.	−	70°±	Y=golden. $Z \wedge 001$ cl.=25°	314
1.793	Green	*Yellow*	*Thortveitite*	Sil.	−	66°	Y=Z. $X \wedge c=+5°$. G.=3.5	211
1.80	Green	*Yellow*	**Acmite**	Sil.	−	60°	Y=yel.-green. 110 cl.	234
1.845	*Yellow*	**Green**	*Kraurite*	Phos.	+	Sm.	Y=Z. X=*a*. Y=*c*	142
			(f) Birefringence extreme: $N_g-N_p>0.0545$					
1.54±	Yel.-green	Yellow	*Copiapite*	Sul.	+	60°±	Y=*yellow*. X⊥001 cl.	108
1.561	*Yel.-green*	Yellow	Humboldtite	Oxal.	+	Lg.	Y=*gr. yellow*. X=*a*. Z=*c*	88
1.569	Yellow	Br.-green	*Griffithite*	Sil.	−	Sm.	Y=olive. X⊥001 cl.	434
1.668	Bl.-green	*Yellowish*	*Symplesite*	Arsen.	−	87°	Y=colorless. X⊥010 cl.	126
1.69±	*Yellowish*	**Br.-green**	*Stilpnomelane*	Sil.	−	Sm.	Y=Z. X⊥001 cleav.	435

1.745	*Yellow*	*Yellow*	*Libethenite*	Phos.	−	83°	Y=yel-green. X=b. Y=c	132
1.810	*Greenish*	*Yellow*	*Olivenite*	Arsen.	+	82°	Y=X. X=a. Y=c	132
1.840	Golden	Green	*Dufrenite*	Phos.	±	90°±	Y=br.-yellow. Z⊥010 cl.	142

XXIV. Minerals Pleochroic in Green and Brown

(a) Birefringence very weak to moderate: $N_g - N_p < 0.0185$

1.55±	*Green*	*Clear brown*	**Cordierite** *	Sil.	−	60°±	Y=green. Ps. Hex. twin.	307
1.60±	Yel.-green	*Brownish*	Prochlorite	Sil.	+	Sm.	Y=X. Z⊥001 cleav. G.=2.8	284
1.66±	Red-brown	Green	*Xanthophyllite*	Sil.	−	Sm.	Y=Z. X⊥001 cl. G.=3.1	286
1.69±	**Green**	Gr.-brown	Arfvedsonite	Sil.	−	Lg.	Y=yel.-brown. X∧c=Sm.	257
1.70±	Red	Green	**HYPERSTHENE**	Sil.	−	70°±	Y=yel.-brown. X=a. Z=c	219
1.73±	Br.-green	*Gr.-brown*	Chloritoid	Sil.	+	Mod.	Y=**blue**. 001 cleav.	438

(b) Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$

1.625	Olive green	Brown	*Roscherite*	Phos.	−	Lg.	Y=yel.-brown. Y∧c=15°	156
1.64±	*Brown*	*Green*	**Anthophyllite** *	Sil.	+	Lg.	Y=X. X=a. Z=c. 110 cl.	240
1.67±	*Brownish*	Green	**HORNBLENDE**	Sil.	−	80°±	Y=*brown, green*. 110 cl.	247
1.68±	*Greenish*	*Greenish*	Diallage *	Sil.	+	60°	Y=*brownish*. 100 part.	228
1.70±	*Greenish*	*Greenish*	**AUGITE** *	Sil.	+	60°	Y=*brownish*. Z∧c=45°±	228

(c). Birefringence strong: $N_g - N_p > 0.0275 < 0.0365$

1.66±	*Brownish*	**Green**	**Tourmaline**	Sil.	−	0°	Max. abs.⊥elong.	301
1.70±	Green	Brownish	Aegirinaugite	Sil.	+	65°±	Y=X. Z∧c=70°±. 110 cl.	232
1.726	**Green**	Brown	Babingtonite	Sil.	+	60°	Y=*brown*. 110 cl.	428
1.80±	**Red-brown**	Olive green	Cronstedtite	Sil.	−	0°±	Y=Z. X⊥001 cleav.	285
1.89±	Brown	**Green**	Ilvaite	Sil.	−	Sm.	Y=**brown**. Z⊥001 cleav.	431

* Often colorless in standard sections: colored in thicker sections.

TABLE III.—COLOR OF MINERALS

XXIV. Minerals Pleochroic in Green and Brown—*continued*

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
			(d) Birefringence very strong: $N_g-N_p>0.0365<0.0545$					
1.70±	Colorless	*Greenish*	Grunerite *	Sil.	−	82°	Y=*brown*. $Z\wedge c=12°$±	242
1.75±	Green	Green, yellow	**EPIDOTE †**	Sil.	−	70°±	Y=brown. $Z\wedge 001$ cl.=25°	314
1.77±	**Brown**	Br.-green	**Acmite**	Sil.	−	66°	Y=Z. $X\wedge c=5°$. Y=*b*	234
1.801	Yel.-green	Or.-brown	*Flinkite*	Arsen.	+	Lg.	Y=X. No cleav. Y=*c*. Z=*a*	154
			(e) Birefringence extreme: $N_g-N_p>0.0545$					
1.625	*Brown*	*Green*	*Bisbeeite* *	Sil.	+	Sm.	Y=X. X⊥laths	411
1.685	Olive green	**Gr.-brown**	*Roscoelite*	Sil.	−	Sm.	Y=X. X⊥001 cleav.	270
1.762	Gr.-blue	*Yel.-brown*	*Dihydrite*	Phos.	±	90°±	Y=yel.-green. $X\wedge c=22°$	135
1.84	**Red-brown**	Green	*Dufrenite*	Phos.	±	90°±	Y=*yellow*. Z⊥010 cl.	142
1.85±	Green	Red-brown	*Ludwigite*	Bor.	+	Sm.	Y=X. Z ‖ fib. G.=4	94
2.19	Red-brown	Red-brown	*Baddeleyite**	ZrO_2	−	30°	Y=oil green. $X\wedge c=12°$	60
2.22	*Green*	*Brown*	*Vauquelinite*	Chrom.	−	0°±	Y=Z. No cleav. X ‖ fib.	121
2.50	**Brown**	**Green**	*Strueverite*	Tit.	−?	0°	Tet. Prism. G.=5.56	164
?	(*a*=) Yel.-brown	**Green**	*Chloroxiphite*	Hal.	−	?	X⊥001 cleav.±. G.=6.8	39

XXV. Minerals Pleochroic in Green and Red

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
			(a) Birefringence very weak to rather strong: $N_g-N_p<0.0275$					
1.64±	Red	Olive green	**Andalusite ***	Sil.	−	85°	Y=green. X=*c*. Z=*a*. 110 cl.	201
1.70±	Red	Green	**HYPERSTHENE ***	Sil.	−	75°±	Y=brown. X=*a*. Z=*c*	219
1.71±	*Yel.-green*	*Greenish*	**Pigeonite ***	Sil.	+	Sm.	Y=*pink*. $Z\wedge c=35°$±	222
1.725	Green	Smoky	*Homilite* *	Sil.	+	80°	Y=**red**. $Y\wedge c=-1°$. X=*b*	424
1.73±	*Green*	*Red*	**Clinozoisite ***	Sil.	+	80°±	Y=*pink*. $Z\wedge 001$ cl.=20°±	312
			(b) Birefringence strong to very strong: $N_g-N_p>0.0275<0.0545$					
1.57±	*Yellow*	Br.-red	**Phlogopite ***	Sil.	−	Sm.	Y=br.-green. X⊥001 cl.	272

1.58±	Green	Br.-red	*Cryophyllite*	Sil.	−	Sm.	Y=Z. X⊥001 cleav.	271
1.726	**Bl.-green**	**Green**	Babingtonite	Sil.	+	62°	Y=*claret*. 110 cleav.	428
1.75±	*Greenish*	• Pink	**EPIDOTE**	Sil.	−	70°±	Y=yellow. Z∧001 cl.=25°±	314
1.78±	*Pink*	*Green*	Scorodite	Arsen.	+	62°	Y=? X=*b*. Z=*c*. G.=3.2	139
1.85±	Pink	Pink	*Törnebohmite*	Sil.	+	26°	Y=bl.-green. G.=4.9	414

(c) Birefringence extreme: $N_g-N_p>0.0545$

1.997	*Red*	*Green*	Cassiterite *	SnO_2	+	0°	Tet. Prism. G.=7±	52
1.997	*Yel.-green*	*Reddish*	Cassiterite *	SnO_2	+	0°	Tet. Prism. G.=7±	52
2.61	*Red*	*Green*	**Rutile ‡**	TiO_2	+	0°	Tet. Prism. G.=4.2	50

XXVI. Gray Minerals

(a) Birefringence very weak or weak: $N_g-N_p<0.0095$

1.64±	*Gray*, etc.: X<Z (or X>Z)		**Apatite ***	Phos.	−	0°	Hex. Prism. G.=3.2	129
1.72±	*Br.-gray*	*Yel.-green*	Vesuvianite *	Sil.	±	0°	Tet. Poor cl. G.=3.4	207
2.38	Gray	Gray	Perovskite	$CaTiO_3$	+	90°±	Cubic. Poor cleav. G.=4	163

(b) Birefringence moderate or rather strong: $N_g-N_p>0.0095<0.0275$

1.725	Bl.-green	Smoky gray	*Homilite* *	Sil.	+	80°	Y=**brownish gray.** Y∧*c*=1°	424
2.38	Gray	Gray	Perovskite	$CaTiO_3$	+	90°±	Cubic. Poor cleav. G.=4	163

(c) Birefringence strong or very strong: $N_g-N_p>0.0275<0.0545$

1.57±	*Yellowish*	Br.-gray	**Zinnwaldite**	Sil.	−	Sm.	Y=Z. X⊥001 cleav.	270
1.86±	**Br.-gray**	Purple	***Purpurite***	Phos.	+	38°	Y=scarlet. X=*c*. Z=*b*	141
1.95±	Gray: X<Z		**Zircon ***	$ZrSiO_4$	+	0°	Tet. Prism. G.=4.7	183

(d) Birefringence extreme: $N_g-N_p>0.0545$

1.87±	Colorless	Ash gray	**Siderite**	$FeCO_3$	−	0°	10$\bar{1}$1 cleav. G.=3.89	76
1.95±	Gray: X<Z		**Zircon ***	$ZrSiO_4$	+	0°	Tet.Prism. G.=4.7	183

* Often colorless in standard sections; colored in thicker sections.

† Usually pleochroic in golden yellow in standard sections; may be colored as above in thicker sections.

‡ Often opaque in standard sections; colored in extremely thin portions.

SUPPLEMENTARY TABLE III.—COLOR OF MINERALS

I. Minerals Pleochroic in Yellow and Blue

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
(d) Birefringence strong to extreme: $N_g - N_p > 0.0275$								
1.692	*Yellow*	**Blue**	*Bandylite*	Bor.	−	0°	X⊥001 cl.	*

III. Yellow Minerals, not Pleochroic, but Anisotropic

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
(c) Birefringence extreme: $N_g - N_p > 0.0545$								
2.07	Yellow		*Curite*	Uran.	?	?	G.=7.19	103

IV. Yellow Minerals, Pleochroic in Yellow (Including Orange to Colorless)

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
(c) Birefringence rather strong. $N_g - N_p > 0.0185 < 0.0275$								
1.736	Colorless	Yellow	*Renardite*	Phos.	−	70°	Y=yellow. X=*a*	148
1.89	*Yellow*	?	*Dumontite*	Phos.	+	Lg.	Y=dark yellow	148
(d) Birefringence strong. $N_g - N_p > 0.0275 < 0.0365$								
1.686	Colorless	**Yellow**	*β-Uranotile*	Sil.	−	65°	Y=deep yellow. Z∧*c*=41°	**
(e) Birefringence very strong: $N_g - N_p > 0.0365 < 0.0545$								
1.542	*Yellow*	*Gr.-yellow*	*Dakeite*	Sul.	−	5°	001 cl.	***
(f) Birefringence extreme: $N_g - N_p > 0.0545$								
1.575	Colorless	Br.-yellow	*Metasideronatrite*	Sul.	+	60°	Y=yellow. Z=*c*	*4
1.630	*Yellow*	Gr.-yellow	*Guildite*	Sul.	+	Sm.	001 and 100 cl.	117
1.650	Colorless	*Yellow*	*Krausite*	Sul.	+	Lg.	X∧*c*=; 35°	115
1.663	*Yellow*	Br.-yellow	*Parabutlerite*	Sul.	+	87°	Y=gr.-yellow. G.=2.55	*4
1.674	*Br.-yellow*	*Canary-yellow*	*Butlerite*	Sul.	−	Lg.	001 cl.	108

1.690	?	Yellow	*Legrandite*	Phos.	+	27°	Y=colorless	137
1.732	Red-yellow	Gr.-yellow	*Lopezite*	Chrom.	+	50°	Y=yellow. 010 cl.	*5
2.098	Light to dark orange		*Clarkeite*	Uran.	−	40°±	G.=6.4	111

V. Minerals Pleochroic in Yellow and Brown

(a) Birefringence very weak to moderate. $N_g - N_p < 0.0185$

1.728	**Brown**	Yellow	*Landesite*	Phos.	−	Lg.	Y=*brown*. X=*c*	156

(c) Birefringence strong to very strong. $N_g - N_p > 0.0275 < 0.0545$

1.78±	Yellow	Red-brown	*Taosite*	Ox.	−	0°	Assoc. with spinel	*6

(d) Birefringence extreme: $N_g - N_p > 0.0545$

1.643	*Yellow*	Gr.-brown	*Hohmanite*	Sul.	−	40°	010 cl. Y=*gr. yellow*	*7
1.718	*Yellow*	Red-brown	*Metahohmanite*	Sul.	+	70°	Y=red−yellow	*7
1.905	Yellow	Brown	*Argentojarosite*	Sul.	−	0°	0001 cl.	114

VI. Minerals Pleochroic in Yellow and Red

(e) Birefringence extreme: $N_g - N_p > 0.0545$

1.643	?	Br.-red	*Castanite*	Sul.	−	Mod.	Y=yellow. $X \wedge c = 22°$ in 010	110
1.725	*Red*	**Red**	*Bermanite*	Phos.	−	74°	Y=*yellow*. X=*c*	*8

* C. Palache and W. F. Foshag: *Am. Mineral.*, XXIII, 1938, p. 85.
** R. Nováček: *Mineral. Abst.*, VI, 1935, p. 149.
*** E. S. Larsen and F. A. Gonyer: *Am. Mineral.*, XXII, 1937, p. 561.
*4 M. C. Bandy: *Am. Mineral.*, XXIII, 1938, p. 714.
*5 M. C. Bandy: *Am. Mineral.*, XXII, 1937, p. 929.
*6 J. de Lapparent: *Comp. Rend.*, CCI, 1935, p. 154.
*7 M. C. Bandy: *Am. Mineral.*, XXIII, 1938, p. 714.
*8 C. S. Hurlbut: *Am. Mineral.*, XXI, 1936, p. 656.

SUPPLEMENTARY TABLE III.—COLOR OF MINERALS

VIII. Brown Minerals, Not Pleochroic, But Anisotropic

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
(b) Birefringence rather strong to strong. $N_g-N_p>0.0185<0.0365$								
1.749	Brown		*Allodelphite*	Arsen.	−	0°±	G.=3.57	440
IX. Brown Minerals Pleochroic in Brown								
(c) Birefringence strong to very strong: $N_g-N_p>0.0275<0.0545$								
1.864	*Brown*	**Red-brown**	*Plumbosynadelphite*	Arsen.	+	40°	Y=brown	*
1.930	Brown, weakly pleochroic		*Fersmanite*	Tit.	−	3°±	Y=*b*. G.=3.44	168
X. Minerals Pleochroic in Brown and Red								
(c) Birefringence extreme: $N_g-N_p>0.0545$								
1.765	Pink	**Brown**	*Murmanite*	Sil.	−	64°	Y=clear brown. G.=2.84	**
XVII. Blue Minerals, Not Pleochroic But Anisotropic								
(a) Birefringence very weak to very strong: $N_g-N_p<0.0545$								
1.512	Pale blue		*Mg-Chalcanthite*	Sul.	−	55°	G.=1.72	***
XVIII. Blue Minerals, Pleochroic in Blue								
(c) Birefringence rather strong: $N_g-N_p>0.0185<0.0275$								
1.735	Lavender	Lavender	*Hodgkinsonite*	Sil.	−	Mod.	Y=colorless	412
(f) Birefringence extreme: $N_g-N_p>0.0545$								
1.90	Colorless	**Violet**	*Ianthinite*	Oxal.	−	Sm.	Y=violet. X⊥100 cl.	60

XIX. MINERALS PLEOCHROIC IN BLUE AND GREEN

(c) Birefringence rather strong. $N_g - N_p > 0.0185 < 0.0275$

1.636	Grass green	Sky blue	*Mitscherlichite*	Hal.	–	0°	G. = 2.42	34

(e) Birefringence extreme: $N_g - N_p > 0.0545$

1.685	Green	*Blue*	*Antofagastite*	Hal.	+	75°	Y = olive green. 110, 001 cl.	*4

XXI. GREEN MINERALS, NOT PLEOCHROIC BUT ANISOTROPIC

2.002	Green		*Lindgrenite*	Molyb.	–	71°	Z⊥010 cl. G. = 4.26	*5

XXII. GREEN MINERALS, PLEOCHROIC IN GREEN

(b) Birefringence weak. $N_g - N_p > 0.0035 < 0.0095$

1.622	*Bluish green*	Bluish green	*Garnierite*	Sil.	+	0°±	Fibrous	*6

(e) Birefringence strong: $N_g - N_p > 0.0275 < 0.0365$

1.78±	Green to colorless		*Vandenbrandeite*	Uran.	?	?	Abn. int. colors	*7

XXIII. MINERALS PLEOCHROIC IN GREEN AND YELLOW

(a) Birefringence very weak to weak: $N_g - N_p < 0.0095$

1.71±	Olive green	Green	*Tawmawite*	Sil.	–	50°	Y = yellow to brown	*8

* C. S. Hurlbut: *Am. Mineral.*, XXII, 1937, p. 526.
** A. E. Fersman: *Mineral. Abst.*, II, p. 263; also V, 1933, p. 198.
*** J. J. Glass in Charles Milton and W. D. Johnston: *Econ. Geol.*, XXXIII, 1938, p. 761.
*4 C. Palache and W. F. Foshag: *Am. Mineral.*, XXIII, 1938, p. 85.
*5 C. Palache: *Am. Mineral.*, XX, 1935, p. 484.
*6 K. Spangenberg: *Zent. Mineral.*, 1938, A, p. 360.
*7 A. Schoep: *N. Jahrb. Mineral.*, 1933, I, p. 250.
*8 P. Eskola: *C. R. Soc. Géol. Finlande*, 7, 1933, p. 26.

TABLE IV.—REFRINGENCE OF MINERALS

THE refringence of minerals in thin section can be estimated or measured by the methods described in Part I of this work on pages 76–79 and 83–85. Accordingly, the following table can be used to good advantage in the study of thin sections in some cases. It is still more useful in the study of powdered minerals, since the refringence of such material can be measured much more accurately by the immersion methods described on pages 79–82, 228–239, and 244–253.

The table of refringence of minerals is divided into two parts, namely, one part including the isotropic minerals, and a second part including the anisotropic minerals. In each part the minerals are arranged in the order of increasing refringence as determined by N, the single index of refraction of the isotropic minerals, and by N_o or N_m for the anisotropic minerals. In the second part of the table (dealing with anisotropic minerals) the indices of refraction are arranged in the first column with indices of positive minerals at the extreme left side and indices of negative minerals indented two spaces to the right. The indices of a few minerals of variable or uncertain sign are in an intermediate position, indented one space to the right.

Many minerals vary more or less in chemical composition and therefore in their physical properties, including their refringence. Such variations are shown by entering each mineral in its proper place as determined by the lowest known value for the refringence (N, N_o or N_m), and entering it again for the highest known value, and connecting these two entries by a vertical line (to the right of the column of indices of refraction) expressing the entire range of variation. Furthermore, when the range of variation of any mineral carries it beyond one page, the mineral is repeated with its minimum index at the head of the next page, so that all minerals having an index within a certain range are listed on any page.

In the second part of the table devoted to anisotropic minerals, the second and third columns give the greatest and least indices of refraction of each mineral, or, if they are unknown, the birefringence ($N_g - N_p$) of the mineral. The fifth column gives the chemical

formula of each mineral when that formula is very short; in other cases it gives the chemical nature of the mineral usually by naming the class of chemical salts to which it belongs, such as carbonate, halide, or silicate. The sixth column gives the crystallographic direction of the cleavage of each mineral and expresses the optic orientation as related to that cleavage; in case the mineral has no cleavage its optic orientation is expressed in relation to its crystal axes. The seventh column gives such other characters as seem most important in each case. The last column gives the page in Part II of this work where a more complete description may be found.

For methods of estimating or measuring the birefringence, see Part I, pages 119–123 and 136–138.

For a discussion of cleavage, see Part I, pages 29–32.

For methods of determining pleochroic formulas, see Part I, pages 170, 171, 204, and 211.

For definitions of X, Y and Z, see Part I, pages 117 and 160.

For methods of distinguishing between X, Y and Z, see Part I, pages 124, 130, and 211.

For methods of determining the optic sign, see Part I, pages 129–135, 138, 148–152, 169, and 206–213.

For methods of estimating or measuring the optic axial angle, see Part I, pages 186–189, 210, 226–227, and 239–244.

For methods of determining the optic orientation of a mineral, see Part I, pages 170, 171, 205, and 212.

For methods of measuring extinction angles, see Part I, pages 126, 137, 173, 174, and 178.

For a list of abbreviations used in the table, see page xiii.

TABLE IV A.—REFRINGENCE OF ISOTROPIC MINERALS

N	Mineral	Chem.	Cleav.	Other Characters	Page
1.339	*Hieratite*	K_2SiF_6	111	G.=2.75. Also hex.	36
1.3395	*Cryolithionite*	Hal.	110	G.=2.78. Oct.	34
1.39	*Hieratite*	K_2SiF_6	111	G.=2.75. Also hex.	36
1.403	*Termierite*	Sil.	None	Clay-like. Also biref.	115
1.406	Opal	Ox.	None	G.=2.1. Sol. HF	57
1.427	*Ralstonite*	Hal.	None	G.=2.61. Also biref.	36
1.434	Fluorite	CaF_2	111	White or tinted	31
1.435	*Yttrocerite*	Hal.	111	G.=3.5. Violet	36
1.439	*Sodalumite*	Sul.	?	G.=1.69. Also biref.	113
1.44-5	*Yttrofluorite*	Hal.	111	Yellow or green	35
1.45	*Hisingerite*	Sil.	None	Data vary. Brown	415
1.45	*Melanophlogite*	Ox.	None	Cubic. Yellow±	54
1.453	*Potassalumite*	Sul.	None	G.=1.76. Also biref.	113
1.454	*Sulfohalite*	Sul.	None	G.=2.49. Dodec.	118
1.458	*Lechatelierite*	SiO_2	None	G.=2.19. Sol. HF	57
1.458	*Tschermigite*	Sul.	None	G.=1.64. Sol. H_2O	113
1.46	Opal	Ox.	None	G.=2.1. Sol. HF	57
1.461	*Melanophlogite*	Ox.	None	Cubic. Yellow±	54
1.47	*Hisingerite*	Sil.	None	Data vary. Brown	415
1.47	*Allophane*	Sil.	None	G.=1.87. Sol. HCl	415
1.47	Halloysite	Sil.	None	G.=2.1. Data vary	415
1.47±	*Neotocite*	Sil.	None	G.=2.7. Brown	413
1.479	**Analcite**	Sil.	None	G.=2.25. Also biref.	293
1.48	*Faujasite*	Sil.	111	G.=1.92. Also biref.	382
1.48	Noselite	Sil.	None	White or tinted	290
1.483	**Sodalite**	Sil.	None	White or tinted	289
1.485	*Evansite*	Phos.	None	G.=1.94. Concretions	145
1.486	*Metacristobalite*	SiO_2	?	G.=2.27. Metastable	54
1.487	**Sodalite**	Sil.	None	White or tinted	289
1.487	*Hackmanite*	Sil.	None	Color fades	290
1.489	**Analcite**	Sil.	None	G.=2.25. Also biref.	293
1.49	*Allophane*	Sil.	None	G.=1.87. Sol. HCl	415
1.49	*Vashegyite*	Phos.	None	G.=1.96. Sol. HCl	144
1.49	*Succinite*	$C_{12}H_{20}O$	None	G.=1.07. Yellow	89
1.49	Sylvite	KCl	100	G.=1.98. Cubes	30
1.495	Noselite	Sil.	None	White or tinted	290
1.496	Hauynite	Sil.	None	Blue, green, etc.	290
1.5	*Rosiéresite*	Phos.	None	G.=2.2. Yellow	145
1.50±	Lazurite	Sil.	None	G.=2.4±. Blue	290
1.50	*Stevensite*	Sil.	None	Like talc	419
1.50±	*Montmorillonite*	Sil.	None	G.=2±. Sol. HF	434
1.504	*Vashegyite*	Phos.	None	G.=1.96. Sol. HCl	144
1.508	**LEUCITE**	Sil.	None	G.=2.47. Also biref.	291
1.508	*Tychite*	Carb.	None	G.=2.46. Sol. HCl	118
1.51	Hauynite	Sil.	None	Blue, green, etc.	290

TABLE IV A.—REFRINGENCE OF ISOTROPIC MINERALS—*continued*

N	Mineral	Chem.	Cleav.	Other Characters	Page
1.47	Halloysite	Sil.	None	G.=2.1. Data vary	415
1.49	*Succinite*	$C_{12}H_{20}O$	None	G.=1.07. Yellow	89
1.50	*Montmorillonite*	Sil.	None	G.=2±. Sol. HF	434
1.514	*Northupite*	Carb.	None	G.=2.38. Also biref.	85
1.517	*β-Sepiolite*	Sil.	None	White or yellow	410
1.517	*Planerite*	Phos.	None	G.=2.65. Green	145
1.52	*Kehoeite*	Phos.	None	G.=2.34. Chalky	158
1.525	*Pollucite*	Sil.	None	G.=2.9. Sol. HCl	293
1.525	*Cornuite*	Sil.	None	Green, blue, brown	413
1.53	*Spadaite*	Sil.	None	Red in mass	413
1.53	**Allanite**	Sil.	?	Alteration product	316
1.53	*Neotocite*	Sil.	None	G.=2.7. Brown	413
1.535	*Langbeinite*	Sul.	None	G.=2.83. Hygrosc.	110
1.538	*Indianaite*	Sil.	None	G.=2.3–2.5	415
1.54	*Kehoeite*	Phos.	None	G.=2.34. Chalky	158
1.543	*Succinite*	$C_{12}H_{20}O$	None	G.=1.07. Yellow	89
1.544	Halite	NaCl	100	G.=2.17. Sol. H_2O	29
1.55	*Montmorillonite*	Sil.	None	G.=2±. Sol. HF	434
1.55	*Cornuite*	Sil.	None	Green, blue, brown	413
1.555	*Collyrite*	Sil.	None	G.=2±. Sol. HF	435
1.56	*Neotocite*	Sil.	None	G.=2.7. Brown	413
1.56	*Zaratite*	Carb.	None	Green. Also biref.	85
1.56±	Bauxite	Ox.	None	G.=2.55. Sol. KOH	49
1.569	Collophane	Phos.	None	Also biref. In sediments	161
1.57	Halloysite	Sil.	None	G.=2.1. Data vary	415
1.57	*Borickite*	Phos.	None	G.=2.7. Brown	157
1.584	*Schroetterite*	Sil.	None	White, green, brown	415
1.589	*Zunyite*	Sil.	111	G.=2.87. Sol. HF	414
1.59±	*Hisingerite*	Sil.	None	G.=3. Brown	415
1.59	*Garnierite*	Sil.	None	Green. Sol. HCl	261
1.59	*Kochite*	Sil.	?	G.=2.93	414
1.60±	*Stibiconite*	Ox.	None	G.=5.2. Also biref.	68
1.602	*Zunyite*	Sil.	111	G.=2.87. Sol. HF	414
1.602	*Voltaite*	Sul.	None	G.=2.79. Oil-green	115
1.61	*Zaratite*	Carb.	None	Green. Also biref.	85
1.61	Bauxite	Ox.	None	G.=2.55. Sol. KOH	49
1.61±	*Gummite*	Ox.	None	G.=4±. Sol. HCl	68
1.618 •	*Diadochite*	Sul.	None	White or yellow	121
1.625	Collophane	Phos.	None	Also biref. In sediments	161
1.63	*Griphite*	Phos.	None	G.=3.4. Brown	155
1.635±	*Pitticite*	Sul.	None	Brown to white	121
1.64	*Picite*	Phos.	None	G.=2.83. Yellow	145
1.64±	*Lagonite*	Bor.	None	Yellow. Rare	94
1.640	*Homilite*	Sil.	Poor	Also biref. with N_m= 1.72±	424
1.642	*Salammoniac*	NH_4Cl	111	G.=1.53. Sol. H_2O	30

TABLE IV A.—REFRINGENCE OF ISOTROPIC MINERALS—*continued*

N	Mineral	Chem.	Cleav.	Other Characters	Page
1.53	**Allanite**	Sil.	?	Alteration product	316
1.57	*Borickite*	Phos.	None	G.=2.7. Brown	157
1.60	*Stibiconite*	Ox.	None	G.=5.2. Also biref.	68
1.618	*Diadochite*	Sul.	None	White or yellow	121
1.63	*Griphite*	Phos.	None	G.=3.4. Brown	155
1.65	*Griphite*	Phos.	None	G.=3.4. Brown	155
1.652±	*Greenalite*	Sil.	None	G.=2.8+. Green, brown	413
1.67	*Borickite*	Phos.	None	G.=2.7. Brown	157
1.67	*Hibschite*	Sil.	None	G.=3.05. Sol. HCl	429
1 675	*Plazolite*[1]	Sil.	None	G.=3.13. Dodec.	183
1.676	*Pharmacosiderite*	Phos.	100	G.=3.0. Green, yellow	143
1.68	*Thorite*	$ThSiO_4$	110	G.=5.3±. Yellow	185
1.69	*Rhodizite*	Bor.	111	Biref. very weak	94
1.70	**Allanite**	Sil.	?	Alteration product	316
1.70	*Diadochite*	Sul.	None	White or yellow	121
1.70	*Polycrase*	Colum.	None	G.=5. Brown	167
1.70	**Pyralspite**	Sil.	None	Red±. Dodec.	178
1.705	**Pyrope**	Sil.	None	Red±. Dodec.	178
1.72	*Thorite*	$ThSiO_4$	110	G.=5.3±. Yellow	185
1.72	*Delvauxite*	Phos.	None	G.=1.9±. Brown	145
1.723	Spinel	$MgAl_2O_4$	111	Red, blue, yellow, etc.	62
1.725	*Rowlandite*	Sil.	None	G.=4.5. Green	420
1.727	*Berzelite*	Arsen.	None	G.=4. Yellow	122
1.73	*Tritomite*	Sil.	Poor	G.=4.2. Brown	420
1.73	**Ugrandite**	Sil.	None	Green, yellow, red	180
1.735	**Grossularite**	Sil.	None	White to brown	180
1.736±	*Periclase*	MgO	100	G.=3.65. Sol. HCl	41
1.737	*Danalite*	Sil.	111	G.=3.43. Pink±	291
1.739	*Helvite*	Sil.	111	G.=3.2. Yellow±	291
1.74	*Pilbarite*	Ox.	None?	G.=4.6. Yellow	185
1.74	*Caryocerite*	Sil.	None	G.=4.29. Brown	420
1.755	*Arsenolite*	As_2O_3	?	G.=3.71. Oct.	43
1.758	*Yttrialite*	Sil.	?	G.=4.58. Green	414
1.76	*Tritomite*	Sil.	Poor	G.=4.2. Brown	420
1.77	**Pyrope**	Sil.	None	Red±. Dodec.	178
1.77	*Mackintoshite*	Ox.	?	G.=5.44. Cloudy	185
1.77	*Melanocerite*	Sil.	None	Reddish brown	420
1.77	**Almandite**	Sil.	None	Red±. Dodec.	178
1.77	*Hercynite*	$FeAl_2O_4$	None?	G.=3.9. Green	62
1.78±	*Gadolinite*	Sil.	None	G.=4±. Green	424
1.79	*Gahnite*	$ZnAl_2O_4$	111	G.=4.5. Green	63
1.79	**Spessartite**	Sil.	None	G.=4±. Red±	178
1.80	Spinel	$MgAl_2O_4$	111	G.=3.6. Red, blue, etc.	62
1.8±	*Manganspinel*	$MnAl_2O_4$	None	G.=4.05. Brown	62
1.81	*Gahnite*	$ZnAl_2O_4$	111	G.=4.5. Green	63

1. N as corrected in *Am. Mineral.*, IX, 1924, p. 94.

TABLE IV A.—REFRINGENCE OF ISOTROPIC MINERALS—*continued*

N	Mineral	Chem.	Cleav.	Other Characters	Page
1.60	*Stibiconite*	Ox.	None	G.=5.2. Also biref.	68
1.70	**Pyralspite**	Sil.	None	Red±. Dodec.	178
1.73	**Ugrandite**	Sil.	None	Green, yellow, red	180
1.735	**Grossularite**	Sil.	None	White to brown	180
1.77	**Almandite**	Sil.	None	Red±. Dodec.	178
1.77	*Hercynite*	$FeAl_2O_4$	None?	G.=3.9. Green	62
1.79	**Spessartite**	Sil.	None	G.=4±. Red±	178
1.81	**Grossularite**	Sil.	None	White to brown	180
1.81	**Spessartite**	Sil.	None	G.=4±. Red	178
1.812	*Beckelite*	Sil.	100	Yellow. Also biref.	420
1.818	*Naegite*	Ox.	?	Green or brown	65
1.82	**Andradite**	Sil.	None	Yellow to red	180
1.82	*Malacon*	Ox.	None	G.=4–4.3. Also biref.	184
1.82	*Roméite*	Antim.	111	Yellow. Also biref.	159
1.83	**Pyralspite**	Sil.	None	Red±. Dodec.	178
1.83	**Almandite**	Sil.	Poor	Red±. Dodec.	178
1.83	*Uvarovite*	Sil.	None	Green. Dodec.	180
1.84	*Bindheimite*	Antim.	111	Yellow. Also biref.	160
1.86	Schorlomite	Sil.	None	Has TiO_2. Brown	183
1.87	*Uvarovite*	Sil.	None	Green. Dodec.	180
1.87	*Bindheimite*	Antim.	111	Yellow. Also biref.	160
1.87	*Stibiconite*	Ox.	None	G.=5.2. Also biref.	68
1.87	*Roméite*	Antim.	111	Yellow. Also biref.	159
1.87	*Chalcolamprite*	Colum.	?	G.=3.77. Brown	164
1.90	**Ugrandite**	Sil.	None	Green, yellow, red	180
1.90	*Hercynite*	$FeAl_2O_4$	None?	G.=3.9. Green	62
1.90	**Andradite**	Sil.	None	Yellow to red	180
1.91	*Cervantite*	Ox.	None?	G.=4. Sol. HCl	67
1.92±	*Betafite*	Titan.	?	G.=4. Green	164
1.92	*Samirésite*	Colum.	?	G.=5.24. Yellow	164
1.93	*Microlite*	Tant.	?	G.=5.5. Yellow	164
1.93	*Malacon*	Ox.	None	G.=4–4.3. Also biref.	184
1.93	*Nantokite*	CuCl	100	G.=3.93. Sol. H_2O	30
1.95	*Neotantalite*	Tant.	?	G.=5.19. Yellow	164
1.96	*Samirésite*	Colum.	?	G.=5.24. Yellow	164
1.96±	***Pyrochlore***	Titan.	111	G.=4.3. Yellow	163
1.98±	***Hatchettolite***	Colum.	?	G.=4.8±. Yellow±	164
1.99	***Neotantalite***	Tant.	?	G.=5.19. Yellow	164
1.998	Sulfur (fused)	S	None	G.=2. Yellow	14
2.00	*Wiikite*	Colum.	?	Yellow. Also biref.	167
2.0	**Limonite**	Ox.	None	G.=3.8. Yellow	47
2.01	Schorlomite	Sil.	None	Has TiO_2. Brown	183
2.05±	Picotite	Ox.	111	G.=4.1. Brown	62
2.05	*Risoerite*	Tant.	?	G.=4.18. Brown	165
2.05	*Eulytite*	Sil.	110	G.=6.1. Yellow	414

TABLE IV A.—REFRINGENCE OF ISOTROPIC MINERALS—*continued*

N	Mineral	Chem.	Cleav.	Other characters	Page
1.91	*Cervantite*	Ox.	None?	G.=4. Sol. HCl	67
2.0	**Limonite**	Ox.	None	G.=3.8. Yellow	47
2.05-6	*Percylite*	Hal.	100	G.=2.25. Blue	37
2.06	*Cervantite*	Ox.	None?	G.=4. Sol. HCl	67
2.06	*Euxenite*	Titan.	None	G.=4.8. Brown	167
2.06	*Cerargyrite*	Hal.	None	G.=5.4-6. Horny	30
2.065	*Mosesite*	Hal.	None	Yellow. Also biref.	34
2.07	**Chromite**	$FeCr_2O_4$	None	Opaque to brown	62
2.087	*Senarmontite*	Sb_2O_3	111	G.=5.2. Also biref.	43
2.09	*Schneebergite*	Antim.	111	G.=5.4. Yellow	160
2.10	*Samarskite*	Colum.	010	Brown. Also biref.	166
2.10	*Fergusonite*	Colum.	111	Brown. Also biref.	164
2.12	*Yttrocrasite*	Titan.	None?	Yellow. Also biref.	167
2.12	*Koppite*	Tant.	None	G.=4.5. Red	164
2.13	*Ampangabéite*	Colum.	None?	G.=4.2±. Red	166
2.14	*Blomstrandinite*	Titan.	010	G.=4.9±. Brown	167
2.15	*Yttrocrasite*	Titan.	None?	Yellow. Also biref.	167
2.15±	*Embolite*	Hal.	None	G.=5.8. Yellow	30
2.15	*Yttrotantalite*	Tant.	010	G.=5.7±. Brown	166
2.15	*Bismutite*	Carb.	None	G.=7.0. Efferv. HCl	86
2.16	**Chromite**	$FeCr_2O_4$	None	Opaque to brown	62
2.16	*Manganosite*	MnO	100	G.=5.18. Green	41
2.16	*Pyrrhite*	Tant.	None?	G.=4.5±. Red	164
2.18	*Koppite*	Tant.	None?	G.=4.5. Red	164
2.19	*Fergusonite*	Colum.	111	Brown. Also biref.	164
2.19	*Zirkelite*	Ox.	None	G.=4.72. Brown	164
2.20±	*Iodembolite*	Hal.	None	G.=5.7. Yellow	30
2.20	*Thorianite*	Ox.	None?	G.=9.32. Brown	50
2.20	*Lewisite*	Antim.	111	G.=4.95. Yellow	162
2.20	*Miersite*	Hal.	110	G.=5.64. Yellow	30
2.20	*Eschynite*	Titan.	None?	G.=5.0±. Brown	167
2.21	*Weslienite*	Antim.	None	Yellow. Also biref.	160
2.215	*Polymignite*	Titan.	Poor	G.=4.8. Brown	167
2.23	*Bunsenite*	NiO	?	G.=6.4. Green, brown	41
2.25	*Samarskite*	Colum.	010	Brown. Also biref.	166
2.25±	*Bromyrite*	AgBr	None	G.=6.0. Yellow	30
2.26±	*Cerargyrite*	Hal.	None	G.=5.4-6. Horny	30
2.26	*Euxenite*	Titan.	None	G.=4.8. Brown	167
2.26	*Bismutite*	Carb.	None	G.=7.0. Also biref.	86
2.26	*Eschynite*	Titan.	None	G.=5.0±. Brown	167
2.27	*Iron*	Fe	100	Opaque. Sol. HCl	16
2.30	**Limonite**	Ox.	None	G.=3.8. Yellow, red	47
2.30	*Brannerite*	Ox.	None	G.=5.1. Green, brown	69

TABLE IV A.—REFRINGENCE OF ISOTROPIC MINERALS—*continued*

N	Mineral	Chem.	Cleav.	Other Characters	Page
2.30±	*Jacobsite*	$MnFe_2O_4$	?	G.=4.75. Brown	63
2 30	*Knopite*	Titan.	100	Brown. Also biref.	163
2 33	*Dysanalite*	Titan.	100	Green. Also biref.	163
2 346	*Marshite*	CuI	110	G.=5.59. Yellow	30
2 35	*Magnesioferrite*	$MgFe_2O_4$	None	Opaque to red	61
2 36	Franklinite	Ox.	111	Opaque to brown	63
2.37 ↑	Sphalerite	ZnS	110	G.=4.09. Brown±	19
2.38 |	Perovskite	$CaTiO_3$	100	Gray, etc. Also biref.	163
2.419 |	Diamond	C	111	G.=3.5. H.=10	13
2.42 |	**MAGNETITE**	Fe_3O_4	110	Opaque. G.=5.17	63
2.47 ↓	Sphalerite	ZnS	110	G.=3.94. Brown	19
2.49	*Eglestonite*	Hal.	None	G.=8.33. Yellow	37
2.69	*Hauerite*	MnS_2	100	G.=3.46. Red	24
2.70	*Alabandite*	MnS	100	G.=4.0. Green	20
>2.72	*Tennantite*	$Cu_6As_2S_6$	None	Red to opaque	26
>2.72	Tetrahedrite	$Cu_6Sb_2S_6$	None	G.=4.4. Red	26
2.849	Cuprite	Cu_2O	111	G.=6. Red	40
2 92	*Selenium* (fused)	Se	None	G.=4.7±. Red	15
Extreme	*Blomstrandite*	Titan.	None	G.=4.2. Brown	167

SUPPLEMENTARY TABLE IV A.—REFRINGENCE OF ISOTROPIC MINERALS

N	Mineral	Chem.	Cleav.	Other Characters	Page
1.369	Cryptohalite	Hal.	111	G.=2.00. Sol. in H_2O	36

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS

N_o or N_m +	N_o or N_m −	N_g (or N_g-N_p)	N_p	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.309		1.313	1.309	**Ice**	H_2O	0001 ⊥ Z	Hex. G. = 0.92	40
	1.312	1.312	1.309	*Malladrite*	Hal.	X = *c*	Ps.Hex. twin. G. = 2.75	37
	1.326	Very weak		*Avogadrite*	Hal.	X = *c*	Y = *b*. 2V = Lg. G. = 2.62	34
	1.328	Very weak		*Villiaumite*	NaF	100	X = yellow, Z = red	30
1.339		.001		*Cryolite*	Na_3AlF_6	001, 110	X = *b*. Z∧*c* = −44°; 2V = 43°	34
	1.349	1.349	1.343	*Chiolite*	Na_2AlF_5	001 ⊥ X	Tet. G. = 3.0	34
1.378		1.390	1.378	*Sellaite*	MgF_2	100, 110	Tet. G. = 3.17	32
	1.396	1.398	1.394	Mirabilite	Sul.	100	Z∧*c* = +29°. 2V = 80°. Sol. H_2O	97
1.40?		Mod.		Chryscolla	Sil.	Z = *c*	Green or brown	44
	1.403	.002		*Termierite*	Sil.	?	G. = 1.2?	415
1.413		.008		*Pachnolite*	Hal.	Z∧*c* = +68°	X = *b*; 2V = 76°	36
	1.414	1.415	1.407	*Thomsenolite*	Hal.	001; Z = *b*	X∧*c* = −52°; 2V = 50°	36
1.44		1.452	1.438	*Erionite*	Sil.	Z = *c*	Orth. G. = 2.0	389
1.448		1.450	1.447	*Variscite* (−H_2O)	Phos.		Z = *a* = lavender; *c* = violet	140
1.448		1.459	1.447	*Taylorite*	Sul.	?	2V = 36°. Orth.?	96
	1.45±	Very weak		*Yttrocalcite*	Hal.	10$\bar{1}$0	G. = 3.19	36
1.45		Weak		*Covellite*	CuS	0001 ⊥ Z	Green to opaque	20
	1.452	1.458	1.430	Kalinite	Sul.	Y∧*c* = 13°	Z = *b*; 2V = 52°	113
	1.452	1.453	1.440	*Lecontite*	Sul.	110 at 76°	X = *a*. Y = *c*. 2V = 40°	97
	1.454	1.456	1.448	*Gearksutite*	Hal.	Y∧*c* = Lg.	X = *b*. 2V = Mod.	35
	1.455	1.461	1.433	Epsomite	Sul.	010 ⊥ X	Y = *c*. 2V = 51°	103
	1.455	1.459	1.435	*Wattevillite*	Sul.	X∧fib. = 0° − Lg.	2V = 48°	112
	1.455	1.456	1.434	*Mendozite*	Sul.	X ‖ fib.	2V = Sm. G. = 1.73	113
	1.456	1.459	1.340	*Sassolite*	$B(OH)_3$	001 ⊥ X±	2V = 7°. G. = 1.48	50
	1.459	1.459	1.431	*Mendozite*	Sul.	X ‖ fib.	2V = 0°. Sol. H_2O	113
1.46		1.54	1.46	Chrysocolla	Sil.	Z ‖ fib.	Green or brown	411
1.462		1.475	1.460	*Picromerite*	Sul.	20$\bar{1}$; Y = *b*	X∧*c* = +14°; 2V = 48°	112
1.464		1.470	1.459	*Aluminite*	Sul.	X = *c*	2V = Lg. G. = 1.66	109

1.465	Weak		Gmelinite	Sil.	$10\bar{1}0$. X = c	2V = Sm. Ps. Hex.	385
1.465	.005		*Mordenite*	Sil.	010 ⊥ Z	X ∧ c = 4°. 2V = Lg.	398
1.466	1.466	1.461	*Ettringite*	Sul.	$10\bar{1}0$. X = c	G. = 1.79. Sol. HCl	115
1.469	1.473	1.469	Tridymite	SiO_2	Y = a; Z = c	2V = 35°. Orth.	58
1.469	1.472	1.447	Borax	Bor.	100; X = b	Z ∧ c = −56°; 2V = 40°	90
1.470	1.471	1.462	*Paraluminite*	Sul.	X ∥ fib.	2V = Sm.	109
1.472	1.479	1.470	*Boussingaultite*	Sul.	$20\bar{1}$; Y = b	X ∧ c = +5°; 2V = 51°	113
1.472	1.488	1.454	*Kernite*	Bor.	001, 100	Z = b. G. = 1.95	90
1.474	1.485	1.464	*Thenardite*	Sul.	001 ⊥ Y; Z = a	2V = 83°. Sol. H_2O	96
1.474	1.480	1.473	*Alunogen*	Sul.	Z ∧ c = 42°	X = b; 2V = Sm.	109
1.475	?	?	*Paternoite*	Bor.	Sym. Ext. in 001	G. = 2.11	92
1.475	1.476	1.471	*Mordenite*	Sil.	010 ⊥ Z	X ∧ c = 4°; 2V = Lg.	398
1.475	1.486	1.475	*Laubanite*	Sil.	110; Z = c?	Mon.? 2V = 0°	438
1.475	1.494	1.466	Carnallite	Hal.	Y = b; Z = a	2V = 70°. Deliques.	34
1.476	1.502	1.456	*Lansfordite*	Carb.	001; X = b	Z ∧ c = Sm. 2V = 61°	85
1.476	1.485	1.473	Natrolite	Sil.	110 at 89°	X = c. Y = b. 2V = 62°	390
1.477	.002±		*Ptilolite*	Sil.	100 ⊥ Y	X = c. 2V = 57°	389
1.478	1.485	1.475	*Alunogen*	Sul.	Z ∧ c = 42°	X = b. 2V = Sm.	109
1.478	1.486	1.471	*Melanterite*	Sul.	Z ∧ c = −62°	Y = b. 2V = 82°	106
1.478	1.485	1.461	*Creedite*	Sul.	100; Y = b	Z ∧ c = 42°. 2V = 64°	121
1.478	1.525	1.478	*Paraffin*	C, H	Z = c	G. = 0.9. F. = 50° ±	17
1.479	1.480	1.479	Gmelinite	Sil.	$10\bar{1}0$. X = c?	2V = Sm. Ps. Hex.	385
1.479	1.482	1.478	*Ferrierite*	Sil.	100 ⊥ X	Z = c. 2V = 50°	398
1.48	1.481	1.450	*Goslarite*	Sul.	010 ⊥ X	Y = c. 2V = 46°	104
1.480	1.488	1.475	*Dietrichite*	Sul.	Z ∧ c = 29° ±	Z = b. 2V = Lg.	117
1.480	1.483	1.476	*Pickeringite*	Sul.	Z ∧ c = 30° ±	Y = b. 2V = Mod.	116
1.480	1.502	1.480	*Hatchettite*	C, H	Z = c	G. = 0.96. F. = 80°	18
1.480	1.487	1.475	*Misenite*	$HKSO_4$	Z ∧ fib. = 33°	2V = Lg.	96
1.48	.02		*Vashegyite*	Phos.	Z ∥ fib.	G. = 1.96	144
1.48	Weak		Phillipsite	Sil.	100, 010	X = b. Z ∧ c = 10°–30°. 2V = 70° ±	393
1.48	Weak		Chabazite	Sil.	$10\bar{1}1$	2V = Sm. Ps. Hex.	384

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g	N_p (or $N_g - N_p$)	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
	1.466	1.466	1.461	*Ettringite*	Sul.	10$\bar{1}$0. X=c	G.=1.79. Sol. HCl	115
1.476		1.485	1.473	Natrolite	Sil.	110. X=c	Y=b. 2V=62°	390
1.478		1.525	1.478	*Paraffin*	C, H	Z=c	G.=0.9. F.=50°±	17
1.48		Weak		Phillipsite	Sil.	100, 010	X=b; Z∧c=10°–30°. 2V=70°±	393
	1.48	Weak		Chabazite	Sil.	10$\bar{1}$1	2V=Sm. Ps. Hex.	384
	1.481	1.486	1.391	*Darapskite*	Sul.	100. 010⊥X	Z∧c=12°. 2V=27°	120
	1.481	1.481	1.461	*Hanksite*	Sul.	0001⊥X	G.=2.56. Sol. H_2O	119
1.482		1.493	1.480	Natrolite	Sil.	100 at 89°	X=c. Y=b. 2V=62°	390
	1.482	1.482	1.478	*Apjohnite*	Sul.	Z∧c=29°	Y=b. 2V=Sm.	117
1.483		1.488	1.479	*Zn-Cu-Melanterite*	Sul.	Y∧fib.=Lg.	Z=b. 2V=Lg.	106
	1.484	1.487	1.483	*Bloedite*	Sul.	X∧c=43°	Y=b. 2V=71°	112
	1.485	Weak		Chabazite	Sil.	10$\bar{1}$1	Z=c? 2V=Sm. Ps. Hex.	384
	1.487	1.487	1.484	*Cristobalite*	SiO_2	X=c	Tet.? G.=2.27	53
	1.487	1.490	1.483	*Leonite*	Sul.	Z∧c=Sm.	Y=b. 2V=86°. Sol. H_2O	112
	1.487±	.001		**Analcite**	Sil.	Diff.	2V=varies. Gel. HCl	293
1.487		1.496	1.484	*Tamarugite*	Sul.	Y∧c=30°±	Z=b±. 2V=60°	115
1.487		1.492	1.487	*Aphthitalite*	Sul.	10$\bar{1}$0. Z=c	G.=2.7. Sol. H_2O	96
	1.488	1.489	1.486	*Bloedite*	Sul.	X∧c=43°	Y=b. 2V=71°. Sol. H_2O	112
1.488		1.542	1.470	*Bechilite*	Bor.	?	2V=62°	92
1.488		1.500	1.488	*Douglasite*	Hal.	Z=c?	Mon.? Green	34
	1.488	1.489	1.485	*Vanthoffite*	Sul.	?	2V=84°. Mono.?	111
	1.489	1.492	1.467	*Morenosite*	Sul.	010⊥X	Y=c. 2V=42°	103
	1.490	1.490	1.471	*Loewite*	Sul.	001⊥X	G.=2.37. Sol. H_2O	111
1.490		1.511	1.473	*Fluellite*	Hal.	Y=a. Z=c	2V=85°. G.=2.17	33
	1.49	.005		*Halotrichite*	Sul.	Z∧c=30°±	G.=1.9±. Sol. H_2O	116
	1.49	1.49	1.48	*Ettringite*	Sul.	10$\bar{1}$0. X=c	G.=1.79. Sol. HCl	115

1.492	1.540	1.412	*Trona*	Carb.	100. $X=b$	$Y \wedge c = +7°$. $2V=72°$	96
1.493	1.500	1.493	*Aphthitalite*	Sul.	$10\bar{1}0$. $Z=c$	Sol. H_2O	96
1.493±	1.495	1.484	*Stellerite*	Sil.	$010 \perp Y$	$Z=a$. $2V=44°$	389
1.495	1.500	1.485	*Epidesmine*	Sil.	$100 \perp Y$	$Z=b$. $2V=40°$	388
1.496	1.496	1.491	*Levynite*	Sil.	$X=c$	Ps. Rhom. Gel. HCl	386
1.496	1.504	1.495	*Struvite*	Phos.	$001 \perp X$	$Z=b$. $2V=37°$	151
1.497	1.501	1.496	Heulandite	Sil.	$010 \perp Z$	$Y \wedge c = 6°±$. $2V=34°±$	397
1.498	1.500	1.494	Stilbite	Sil.	$010 \perp Y$	$X \wedge c = 5°±$. $2V=33°±$	395
1.500	1.543	1.418	*Nitroglauberite*	Nit.	X ‖ elong.	$2V=61°$	120
1.500	.01		*Aluminite?*	Sul.	Ext. Ang. Lg.	$2V=$Lg. Mon.?	109
1.50	1.503	1.498	*Wellsite*	Sil.	$010 \perp Z$	$X \wedge c = 4°$. $2V=39°$	395
1.5±	Very weak		*Pseudomesolite*	Sil.	110 at 90°±	$Z \wedge c = 20°$. $2V=$Sm.	399
1.500	Weak		*Bilinite*	Sul.	Ext. at 37°	G.=1.87	116
1.500	1.500	1.464	*Thaumasite*	Sul.	$X=c$	Hex. G.=1.87	119
1.501	1.505	1.499	Heulandite	Sil.	$010 \perp Z$	$Y \wedge c = 6°±$. $2V=34°±$	397
1.501	.015		*Didymolite*	Sil.	$010 \perp Y$	$X \wedge c = 40°$. $2V=83°±$	428
1.502?	1.511	1.490	**Antigorite**	Sil.	$001 \perp X$	$2V=$Lg. Greenish: $X<Z$	280
1.503	1.545	1.503	*Paraffin*	C, H	$Z=c$	G.=0.9. F.=50°±	17
1.503	1.539	1.500	*Uranothallite*	Carb.	$100 \perp X$	$2V=40°±$. Orth.	88
1.503	1.510	1.501	*Prosopite*	Hal.	$Z \wedge c = 50°$	$Y=b$. $2V=63°$	34
1.504	1.508	1.500	Stilbite	Sil.	$010 \perp Y$	$X \wedge c = 5°±$. $2V=33°±$	395
1.504	1.520	1.491	Ulexite	Bor.	$Y \wedge c = 23°$	$Z=b$. $2V=$Lg.	93
1.505	.0005		*Mesolite*	Sil.	110, $1\bar{1}0$	Tr. $Y \wedge c = 3°±$	399
1.505	1.508	1.503	*Harmotome*	Sil.	$010 \perp Z$	$X \wedge c = 62°$. $2V=43°$	395
1.505	1.516	1.494	*Kainite*	Sul.	100, 110	$Y=b$. $X \wedge c = 8°$. $2V=85°$	120
1.505	1.506	1.335	Niter	KNO_3	011 at 70°	$X=c$. $Y=a$. $2V=7°$. G.=2.1	89
1.505	.01		*Deweylite*	Sil.	Z ‖ fib.	$2V=$Sm. G.=2.3±	261
1.506	1.506	1.344	*Nitromagnesite*	Nit.	110?	$2V=5°$. Mono.	89
1.506	.011		*Parasepiolite*	Sil.	Z ‖ fib.	$2V=50°$. Gel. HCl	410
1.506	1.506	1.468	*Thaumasite*	Sul.	$X=c$	Hex. G.=1.87	119

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g (or $N_g - N_p$)	N_p	Mineral	Chem.	Cleavage Opt. Orient.	Other Characters	Page
1.48		Weak		Phillipsite	Sil.	100, 010	X=*b*. Z∧*c*=10°–30°, 2V=70°±	393
	1.505	.01		*Deweylite*	Sil.	Z ‖ fib.	2V=Sm. G.=2.3	261
1.507		1.528	1.495	*Bischofite*	Hal.	Y∧*c*=+10°	X=*b*. 2V=79°	32
1.508		1.545	1.504	*Ussingite*	Sil.	001, 110	Tr. 2V=39°	439
1.508		1.509	1.508	**LEUCITE**	Sil.	Poor	2V=0°±. Ps. Isom.	291
1.509		1.575	1.504	*Pirssonite*	Carb.	Y=*c*. Z=*b*	2V=33°. G.=2.35	87
	1.509	1.509	1.486	*Nocerite*	Hal.	X=*c*	Hex. G.=2.96	38
	1.509	1.509	1.500	Cancrinite	Sil.	10$\bar{1}$0. X=*c*	Efferv. Gel. HCl.	301
1.51		.010		Phillipsite	Sil.	010⊥X	Z∧*c*=20°±. 2V=70°±	393
1.510		1.516	1.504	*Petalite*	Sil.	001⊥Y	Z=*b*. 2V=84°. Mono.	309
1.510		1.512	1.502	*Epistilbite*	Sil.	010⊥Y	Z∧*c*=−10°. 2V=44°	396
	1.510	1.521	1.488	*Uranospathite*	Phos.	001⊥X	Y=*b*. 2V=69°. Ps. Tet.	146
	1.51	.01±		*Racewinite*	Sil.	None	G.=1.96±	433
	1.51	1.520	1.495	*Inyoite*	Bor.	001. Y=*b*	X∧*c*=+37°. 2V=70°	92
	1.512	1.512	1.487	*Nocerite*	Hal.	X=*c*	Hex. G.=2.96	38
1.512		1.523	1.510	*Brewsterite*	Sil.	010⊥Z	X∧*c*=+22°. 2V=65°	397
1.512		1.522	1.508	**Chrysotile?**	Sil.	Z ‖ fib.	Y=*b*. 2V=Lg.	260
1.512		1.524	1.505	*Flagstaffite*	H, C, O	Y=*b*. Z=*a*	2V=77°. G.=1.1	88
	1.512	1.512	1.498	*Hydrotalcite*	Carb.	0001⊥X	Efferv. HCl. G.=2.06	87
1.513		1.518	1.512	Thomsonite	Sil.	010⊥Z	Y=*c*. 2V=54°±	387
	1.514	1.514	1.509	Carnegieite	Sil.	?	2V=13°±. Tr.	299
1.515		1.520	1.514	*Gonnardite*	Sil.	Z ‖ fib.	2V=52°. Gel. HCl	387
1.515		1.54	1.515	*Ozocerite*	H, C	?	2V=0°±. Burns	18
	1.516	1.523	1.443	*Gaylussite*	Carb.	110 at 69°	X=*b*. Z∧*c*=−14°. 2V=34°	87
	1.517	1.518	1.501	*Syngenite*	Sul.	110, 100	Z=*b*. Y∧*c*=3°. 2V=28°	111
1.517		1.533	1.514	*Newberyite*	Phos.	010⊥Y	Z=*c*. 2V=45°	123
1.518		1.561	1.518	*Fibroferrite*	Sul.	Z ‖ fib.	2V=0°. Yellow; X<Z	109
1.518		1.533	1.516	*Felsöbanyite*	Sul.	001⊥Z	2V=48°. G.=2.33	109

1.518	1.522	1.518	*Leifite*	Sil.	10$\bar{1}$0	Inclusions. G.=2.57	429
1.519±	Very weak		*Davyne*	Sil.	10$\bar{1}$0	Efferv. Gel. HCl	301
1.519	1.520	1.512	Scolecite	Sil.	110 at 90°±	$X \wedge c$=+16°. Z=b. 2V=36°	390
1.52	.03		*Hautefeuillite*	Phos.	010⊥Y	$Z \wedge a$=45°. 2V=45°	125
1.52	1.543	1.510	*Bobierrite*	Phos.	010⊥X	$Z \wedge c$=+29°. 2V=71°	125
1.52	1.561	1.509	*Larderellite*	Bor.	001. X=*b*	$Y \wedge a$=Sm. 2V=60°	91
1.52	Strong		*Zebedassite*	Sil.	Z ‖ fib.	G.=2.19. Gel. HCl	432
1.52	1.523	1.516	**MICROCLINE**	Sil.	001, 010	2V=83°±. G.=2.55	364
1.52±	1.525	1.515	Sepiolite	Sil.	Z ‖ fib.	2V=30°±. G.=2.0	410
1.52	Weak		*Chlorocalcite*	$KCaCl_3$	001, 110	Ps. Isom. Orth.?	33
1.521	1.529	1.521	*Microsommite*	Sil.	10$\bar{1}$0. Z=*c*	G.=2.45. Gel. HCl	301
1.522	1.527	1.522	*Natrodavyne*	Sil.	10$\bar{1}$0. Z=*c*	Efferv. Gel. HCl	301
1.522	1.522	1.513	*Tachyhydrite*	Hal.	10$\bar{1}$1. X=*c*	Deliques. G.=1.67?	32
1.522	1.524	1.518	**ORTHOCLASE**	Sil.	001, 010	$X \wedge a$=6°. Z=*b*. 2V=70°±	361
1.523	1.530	1.521	**Gypsum**	Sul.	010⊥Y	$Z \wedge c$=+52°. 2V=58°	104
1.523	1.588	1.518	*Hatchettite*	$C_{38}H_{78}$	One⊥Z	2V=Sm.	18
1.523	1.532	1.518	*Gyrolite*	Sil.	001⊥X	2V=? Sol. HCl	408
1.524	1.524	1.502	Cancrinite	Sil.	10$\bar{1}$0. X=*c*	Efferv. Gel. HCl	301
1.524	1.525	1.513	*Laumontite*	Sil.	010, 110	Y=*b*. $Z \wedge c$=−30°±. 2V=53°±	391
1.524	1.528	1.520	*Searlesite*	Sil.	100. Z=*b*	$X \wedge c$=30°. 2V=Lg.	423
1.524±	1.524	1.517	**SANIDINE**	Sil.	001, 010	$X \wedge a$=6°±. 2V=Sm.	361
1.525	.01		*Deweylite*	Sil.	Z ‖ fib.	2V=Sm. G.=2.3	261
1.525	1.532	1.523	*Chalcoalumite*	Sul.	Several	Tr.? 2V=Lg. Green	117
1.525	1.586	1.508	*Sideronatrite*	Sul.	100⊥X	Z=*c*. 2V=58°.	115
1.526	1.550	1.508	*Kaliborite*	Bor.	100, 001	X=*b*. $Z \wedge c$=+65°. 2V=81°	94
1.526	1.529	1.522	**MICROCLINE**	Sil.	001, 010	Z=*b*±. 2V=83°±	364
1.526	1.528	1.522	**ORTHOCLASE**	Sil.	001, 010	$X \wedge a$=6°. Z=*b*. 2V=70°±	361
1.526	1.534	1.513	*Fe-Cu-Chalcanthite*	Sul.	?	2V=60°±	107
1.527	1.545	1.523	*Hydromagnesite*	Carb.	010⊥Z	$Y \wedge c$=−43°. 2V=Mod.	85
1.528±	1.529	1.523	**ANORTHOCLASE**	Sil.	001, 010	$X \wedge a$=9°±. 2V=50°±	366
1.528	1.575	1.506	*Copiapite*	Sul.	001⊥X. Y=*b*	2V=60°±. X=green, Z=yellow	108
1.529	1.536	1.525	**ALBITE**	Sil.	001, 010	$Z \wedge b$=12°±. 2V=70°	369

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g	N_p or N_g-N_p	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.513		1.518	1.512	Thomsonite	Sil.	010⊥Z	Y=*c*. 2V=54±	387
1.518		1.561	1.518	*Fibroferrite*	Sul.	Z ∥ fib.	2V=0°. Yellow. X<Z	109
	1.524	1.528	1.520	*Searlesite*	Sil.	100. Z=*b*	X∧*c*=30°. 2V=Lg.	423
	1.526	1.534	1.513	*Fe-Cu-Chalcanthite*	Sul.	?	2V=60°±	107
1.527		1.545	1.523	*Hydromagnesite*	Carb.	010⊥Z	Y∧*c*=43°. 2V=Mod.	85
1.528		1.575	1.506	*Copiapite*	Sul.	001⊥X; Y=*b*	2V=60°±. X=green, Z=yellow	108
1.529		1.536	1.525	**ALBITE**	Sil.	001, 010	Z∧*b*=12°±. 2V=70°	369
1.530		1.540	1.527	*Hydromagnesite*	Carb.	010⊥Z	Y∧*c*=43°. 2V=Mod.	85
1.530		1.544	1.522	*Tavistockite*	Phos.	100⊥Y	Z=*c*. 2V=74°	154
1.530		1.550	1.525	*Wapplerite*	Arsen.	010⊥Z±	2V=35°. G.=2.48	124
	1.530	1.538	1.511	Chalcanthite	Sul.	Poor	Tr. 2V=56°	106
	1.530	1.542	1.518	*Minasragrite*	Sul.	010, 110	Ext. Ang.=12°. Blue; X>Z	110
	1.53±		.005±	Marialite	Sil.	110 at 90°	2V=0°. G.=2.6	296
	1.531	1.531	1.510	*Bechilite*	Bor.	?	2V=0°	92
	1.531	1.534	1.528	**Hyalophane**	Sil.	001, 010	X∧*a*=+2°. 2V=74°	360
1.531		1.583	1.518	Kieserite	Sul.	11$\bar{1}$, 11$\bar{3}$	Z∧*c*+76°. 2V=55°	104
1.532		1.542	1.530	Thomsonite	Sil.	010⊥Z	2V=54°. Gel. HCl	387
	1.532	1.532	1.529	*Milarite*	Sil.	X=*c*	2V=Sm. Ps. Hex.	429
	1.532	1.536	1.515	*Glauberite*	Sul.	001. Z=*b*	X∧*c*=+37°. 2V=Sm.	110
	1.532	1.532	1.527	*Kaliophilite*	Sil.	X=*c*	G.=2.56. Gel. HCl	300
	1.533	1.535	1.513	*Searlesite*	Sil.	100. Z=*b*	X∧*c*=30°. 2V=Mod.?	423
1.533		1.545	1.530	*Echellite*	Sil.	010⊥*b*	Y=*c*. 2V=50°	389
	1.533	1.533	1.526	Chalcedonite	SiO_2	Fibers	G.=2.6	57
1.534		1.575	1.533	*Fibroferrite*	Sul.	Z ∥ fib.	2V=0°±. Yellow; X<Z	109
1.534		1.552	1.525	Wavellite	Phos.	010⊥X	Z=*c*. 2V=72°	144
1.534		1.565	1.517	*Hydroboracite*	Bor.	100, 010	Z∧*c*=31°. 2V=Lg.	92
	1.534	1.557	1.489	*Artinite*	Carb.	Y ∥ fib.	2V=71°. G.=2.03	84

1.534	1.534	1.514	*Zincaluminite*	Sul.	X=c	G.=2.26	115
1.535	1.586	1.523	Kieserite	Sul.	$11\bar{1}$, $11\bar{3}$	Z∧c=+76°. 2V=55°	104
1.535	1.582	1.530	*Quetenite*	Sul.	110	2V=34°. Brown; X<Z	116
1.535	1.535	1.537	Apophyllite	Sil.	001⊥Z	Abn. int. colors	262
1.535	1.536	1.528	*Kaliophilite?*	Sil.	?	2V=39°. Twin.	300
1.535	1.560	1.500	*Meyerhofferite*	Bor.	010	2V=79°. G.=2.12	93
1.536	Weak		*Brugnatellite*	Carb.	0001⊥X	Efferv. HCl	87
1.536	1.541	1.532	**ALBITE**	Sil.	001, 010	Z∧b=15°±. 2V=75°	369
1.536	.001±		*Milarite*	Sil.	X=c	2V=0°±. G.=2.57	429
1.536	1.543	1.517	*Fe-Cu-Chalcanthite*	Sul.	?	2V=60°±. Sol. H_2O	107
1.536	1.539	1.532	**Cordierite**	Sil.	010⊥Z	X=c. 2V=60°±. Twins	307
1.536	1.541	1.532	**OLIGOCLASE**	Sil.	001, 010	Z=b±. 2V=90°±	371
1.536	1.536	1.532	**NEPHELITE**	Sil.	X=c	G.=2.6. Gel. HCl	298
1.537	1.537	1.533	*Kaliophilite*	Sil.	X=c	G.=2.56. Gel. HCl	300
1.537	1.545	1.528	***Siderotile***	Sul.	?	2V=Mod. Sol. H_2O	107
1.537±	1.541	1.530	*Okenite*	Sil.	010	2V=Lg. Gel. HCl	413
1.539	1.539	1.532	Chalcedonite	SiO_2	Fibers	G.=2.6	57
1.539	1.546	1.516	Chalcanthite	Sul.	Poor	2V=56°. Sol. H_2O	106
1.539	1.539	1.511	*Mellite*	Al, C, O, H	Poor	Tet. G.=1.6	88
1.540	1.540	1.510	*Brugnatellite*	Carb.	0001⊥X	Efferv. HCl	87
1.54±	1.548	1.531	*Gismondite*	Sil.	101. X=b	Z=a±. 2V=84°±	373
1.54	1.545	1.520	*Lueneburgite*	Phos.	110 at 73°	X∧c=45°. Y=b. 2V=Mod.	161
1.540	1.544	1.527	***Sulfoborite***	Sul.	110 at 64°	X=c. Y=b. 2V=70°	120
1.540	.01		*Gyrolite*	Sil.	0001⊥X	Also biax. Sol. HCl	408
1.542	1.542	1.516	***Stichtite***	Carb.	0001⊥X	Efferv. HCl. Lilac	87
1.542	1.596	1.466	*Dawsonite*	Carb.	110 at 66°	X=a. Y=c. 2V=77°. Efferv. HCl	87
1.543	Very weak		Apophyllite	Sil.	001⊥X	Abn. int. colors	262
1.543±	1.555	1.542	**Chrysotile**	Sil.	Z ‖ fib.	Y=b. 2V=32°±	260
1.544	1.553	1.544	**QUARTZ**	SiO_2	Z=c	G.=2.65. Sol. HF	54
1.544	1.546	1.544	*Epididymite*	Sil.	001⊥Y; 010⊥Z	2V=22°. Ps. Hex. twin.	418
1.545	1.547	1.542	**Hyalophane**	Sil.	001, 010	Z=b. 2V=78°	360

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g	N_p or $N_g - N_p$	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.528		1.575	1.506	*Copiapite*	Sul.	001⊥X; Y=*b*	2V=60°±. X=green, Z=yellow	108
	1.53	.005±		Marialite	Sil.	110	2V=0°. G.=2.6	296
	1.536	1.539	1.532	**Cordierite**	Sil.	010⊥Z; X=*c*	2V=60°±. Twins	307
1.536		1.541	1.532	**OLIGOCLASE**	Sil.	001, 010	Z=*b*±. 2V=90°±	371
	1.536	1.536	1.532	**NEPHELITE**	Sil.	X=*c*	G.=2.6. Gel. HCl	298
	1.540	.01		*Gyrolite*	Sil.	0001⊥X	Also biax. Sol. HCl	408
	1.545	Weak		*Eucryptite*	Sil.	0001⊥X	Hex. G.=2.67	300
	1.545	1.545	1.503	*Pholidolite*	Sil.	001⊥X	2V=10°±. G.=2.41	435
	1.545	1.545	1.525	Vermiculite *	Sil.	001⊥X	2V=Sm. Yellow; X<Y	434
1.546		1.546	1.540	Marialite	Sil.	110 at 90°	G.=2.6	296
1.546		1.551	1.539	*Brushite*	Phos.	010⊥Z	X∧*c*=−72°. 2V=84°	123
1.546		1.551	1.545	*Eudidymite*	Sil.	001. Y=*b*	Z∧*c*=59°. 2V=30°	418
	1.546	1.546	1.540	Dipyre	Sil.	100	Inclusions common	296
	1.547	1.595	1.438	*Oxammite*	Oxal.	X=*c*. Y=*a*	2V=62°	89
1.547		1.564	1.541	*Voglite*	Carb.	One⊥X±	2V=60°. Efferv. HCl	88
	1.548	1.548	1.540	*Gyrolite*	Sil.	0001⊥X	Also biax. Sol. HCl	408
	1.548	1.549	1.535	*Centrallasite*	Sil.	One⊥X	2V=Sm. Fibers	409
	1.548	1.550	1.530	*Co-Chalcanthite*	Sul.	Poor	2V=Mod. Pink	107
1.548		1.572	1.544	*Botryogen*	Sul.	010⊥X	2V=41°. X=yellow, Z=red	116
1.549		1.553	1.545	**OLIGOCLASE**	Sil.	001, 010	2V=90°±. Lam. twin	371
	1.549	1.549	1.544	**NEPHELITE**	Sil.	Poor	Hex. G.=2.6. Gel. HCl	298
	1.549	1.554	1.539	*Edingtonite*	Sil.	110 at 90°±	X=*c*. Y=*b*. 2V=50°±	389
1.549		1.553	1.545	**ANDESINE**	Sil.	001, 010	2V=90°±. Lam. twin.	372
1.550		1.600	1.540	*Copiapite*	Sul.	001⊥X. Y=*b*	2V=60°±. X=green, Z=yellow	108
1.550		1.635	1.533	*Rhomboclase*	Sul.	001⊥X. Y=*a*	2V=Sm. X=red, Z=yellow	108
1.55		.02		*Zepharovichite*	Phos.	Z ‖ fib.	G.=2.37. Sol. HCl	141
	1.55	.01?		*Pyroaurite*	Carb.	0001⊥X	Efferv. HCl	87

1.55	1.55	1.53	*Ascharite*	Bor.	X ‖ fib.	2V = Sm.	92
1.55	.01±		**Antigorite**	Sil.	001 ⊥ X	X = yellow, Z = green	280
1.55	1.55	1.53	**Lepidolite**	Sil.	001 ⊥ X	Z = *b*. 2V = 40°±. Pink	270
1.552	1.557	1.552	*Coquimbite*	Sul.	Poor	Z = *c*. Rhom.	107
1.553	1.584	1.553	*Narsarsukite*	Sil.	110 at 90°	Z = *c*. Tet. Yellow; X < Z	429
1.554	.016		*Grothine*	Sil.	X = *b*. Y = *c*	2V = Mod.	432
1.554	1.576	1.554	Gibbsite	Ox.	001	2V = Sm. G. = 2.35	48
1.555	Mod.		*Soumansite*	Phos.	?	Tet. Also biax.	151
1.555	1.562	1.551	*Vauxite*	Phos.	Z ⊥ 010 ±	2E = 32°. Blue: X < Y	157
1.555	1.650	1.490	*Whewellite*	Oxal.	001; 010 ⊥ X	Z ∧ *c* = +29°. 2V = 84°	89
1.555	.01±		*Saponite*	Sil.	One ⊥ X	2V = 0°. G. = 2.26	437
1.555	.01		*Morinite*	Phos.	100. Y = *b*	X ∧ *c* = +30°. 2E = 40°	158
1.556	1.559	1.552	*Miloschite*	Sil.	001 ⊥ X ±	2V = 90°±. G. = 2.1	416
1.557	1.562	1.555	**ANDESINE**	Sil.	001, 010	2V = 90°±. Lam. twin.	372
1.557	1.562	1.555	**LABRADORITE**	Sil.	001, 010	2V = 80°±. Lam. twin.	374
1.558	1.573	1.554	*Paravauxite*	Phos.	010. Tric.	2V = 35°. Sol. HCl	157
1.558	1.582	1.551	*Metavariscite*	Phos.	X = *a*. Y = *b*	2V = 55°. Sol. HCl	141
1.558	1.562	1.552	*Beryllonite*	Phos.	001 ⊥ X	2V = 68°. Ps. Hex. twin.	149
1.559	1.627	1.559	*Ferrinatrite*	Sul.	10$\bar{1}$0, Z = *c*	G. = 2.56. Sol. H_2O	114
1.56±	.04		Magnesiopectolite	Sil.	X ‖ fib.	G. = 2.69	420
1.560	1.560	1.495	*Trudellite*	Sul.	X = *c*	G. = 1.93	119
1.56	Very weak		**Penninite**	Sil.	001 ⊥ X ±	2V = Sm. Green: X < Z	281
1.56	.03±		**Zinnwaldite**	Sil.	001 ⊥ X ±	Z = *b*. 2V = 35°±. Brown: X < Z	270
1.56	Weak		*Calcioferrite*	Phos	001 ⊥ X ±	2V = 0°±. Yellow, green	156
1.56	1.56	1.53	*Nepouite*	Sil.	001 ⊥ X ±	2V = 0°±. X = green, Z = yellow	279
1.56	.02±		*Faratsihite*	Sil.	001 ⊥ X ±	Yellow	416
1.561	1.692	1.494	*Humboldtite*	Oxal.	110 at 75°. Y = *b*	Z = c. 2V = Lg. X = green, Z = yel.	88
1.562	1.57	1.552	**Cordierite**	Sil.	010 ⊥ Z	X = *c*. 2V = 60°±. Ps. Hex.	307
1.562	1.567	1.548	Polyhalite	Sul.	100. Tric.	Lam. twin. G. = 2.78	113
1.564	.019		Brucite	Ox.	0001 ⊥ Z	Rhom. G. = 2.4	42

* E. V. Shannon; *Am. Jour. Sci.* CCXV, 1928, p. 20.

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g (or $N_g - N_p$)	N_p	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
	1.545	1.545	1.525	Vermiculite	Sil.	001 ⊥ X	2V = Sm. Yellow: X < Y	434
	1.546	1.546	1.540	Dipyre	Sil.	100	Inclusions common	296
	1.55	.01±		**Antigorite**	Sil.	001 ⊥ X	X = yellow, Z = green	280
	1.55	1.55	1.53	**Lepidolite**	Sil.	001 ⊥ X	Z = *b*. 2V = 40°±. Pink	270
1.554		1.576	1.554	Gibbsite	Ox.	001	2V = Sm. G. = 2.35	48
1.557		1.562	1.555	**LABRADORITE**	Sil.	001, 010	2V = 80°±. Lam. Twin.	374
	1.56	Very weak		**Penninite**	Sil.	001 ⊥ X±	2V = Sm. Green: X < Z	281
	1.56	.03±		**Zinnwaldite**	Sil.	001 ⊥ X±	Z = *b*. 2V = 35°±. Brown: X < Z	270
	1.56	Weak		*Calcioferrite*	Phos.	001 ⊥ X±	2V = 0°±. Yellow, green	156
	1.56	1.56	1.53	*Nepouite*	Sil.	001 ⊥ X±	2V = 0°±. X = green, Z = yellow	279
	1.564	1.565	1.535	**Phlogopite**	Sil.	001 ⊥ X	Y = *b*. 2V = 10°±. G. = 2.75	272
	1.565	.025±		**Lepidolite**	Sil.	001 ⊥ X	2V = Sm. Pink	270
1.565		1.574	1.560	*Elpidite*	Sil.	110 at 54°	Y = *b*. Z = *a*. 2V = 75°±	400
1.565		1.575	1.565	*Pinnoite*	Bor.	Z = *c*	Tet. G. = 2.29	92
	1.565	1.565	1.559	*Reyerite*	Sil.	001 ⊥ X	Rhom. G. = 2.52	408
	1.565	1.567	1 561	**Kaolinite**	Sil.	001 ⊥ X±	Z = *b*. 2V = 60°. Ps. Hex.	264
	1.565	1.565	1.560	*Zeophyllite*	Sil.	001 ⊥ X	Also biax.	408
	1.565	.01		*Pyroaurite*	Carb.	0001 ⊥ X	Efferv. HCl. Red: X < Z	87
	1.565	Weak		*Zaratite*	Carb.	Paral. Ext.	Efferv. HCl. Green	85
	1.565	1.570	1.550	*Variscite*	Phos.	?	G. = 2.54. Sol. HCl	140
1.567		1.589	1.567	Gibbsite	Ox.	001	2V = Sm. G. = 2.35	48
1.567		1.572	1 564	**LABRADORITE**	Sil.	001, 010	2V = 80°±. Lam. twin.	374
1.567		1.590	1.563	*Norbergite*	Sil.	?	2V = 49°. G. = 3.14. Gel. HCl	196
	1.567	1.572	1.564	**BYTOWNITE**	Sil.	001, 010	2V = 80°±. Lam. twin.	376
1.568		.01		*Natroalunite*	Sul.	0001 ⊥ Z	G. = 2.6	114
1.568		1.580	1.565	*Isoclasite*	Phos.	010 ⊥ Y	Z∧*c* = Sm. 2V = 50°±	137

1.568	1.568	1.564	Beryl	Sil.	X=*c*	Also biax. Pneumat.	212
1.569	1.572	1.485	*Griffithite*	Sil.	001⊥X	2V=Sm. X=yellow, Z=green	434
1.570	1.570	1.545	Dipyre	Sil.	100. X=*c*	Tet. Incl. common	296
1.57±	1.576	1.568	*Jurupaite*	Sil.	Z∧fib.=31°	G.=2.75. Sol. HCl	412
1.57±	1.585	1.555	*Tengerite*	Carb.	X ‖ fib.	2V=Lg.	86
1.57	.026±		*Xylotile*	Sil.	Z ‖ fib.	2V=Sm. Yellow: X<Z	261
1.570	1.582	1.569	*Wagnerite*	Phos.	Y=*b*	Z∧*c*=22°. 2V=26°	134
1.57	.016±		*Barrandite*	Phos.	Z ‖ fib.	2V=Mod. G.=2.6	140
1.57	Very weak		**Penninite**	Sil.	001⊥Z	2V=Sm. Green: X<Z	281
1.57	.006±		**Clinochlore**	Sil.	001⊥Z	2V=Sm. Green: X>Z	283
1.57	1.570	1.545	Mizzonite	Sil.	100. X=*c*	Tet. Incl. common	297
1.571	1.596	1.563	*Hoernesite*	Phos.	100. X=*b*	Z∧*c*=+32°. 2V=60°	125
1.571	1.583	1.524	*Roemerite*	Sul.	001?	2V=51°. Brown: X=Z<Y	117
1.572	1.592	1.572	*Alunite*	Sul.	0001⊥Z	Rhom. G.=2.60	113
1.572	1.575	1.555	*Hannayite*	Phos.	010⊥X	Y∧*c*=33°. 2V=42°	151
1.574	1.580	1.558	*Bassetite*	Phos.	010⊥X	Z∧*c*=4°. 2E=110°	146
1.575	.01		*Loewigite*	Sul.	0001?	G.=2.58	114
1.575	1.575	1.547	*Errite*	Sil.	0001⊥X	Brown; pleo.	407
1.575	1.577	1.553	*Autunite*	Phos.	001⊥X. Y=*b*	2V=33°. Yellow: X<Z	146
1.575	.04±		**Talc**	Sil.	001⊥X. Z=*b*	2V=20°±. Insol.	262
1.576	1.614	1.570	Anhydrite	Sul.	001⊥X	010⊥Y. 2V=42°	98
1.576	1.588	1.574	*Augelite*	Phos.	110 at 67°	Y=*b*. Z∧*c*=−34°. 2V=51°	143
1.576	1.588	1.562	*Spherite*	Phos.	Fibers	2V=Lg.	144
1.576	1.576	1.546	*Parsettensite*	Sil.	0001⊥X	Yellow: X>Z	407
1.578	1.582	1.571	**BYTOWNITE**	Sil.	001, 010	2V=80°±. Lam. twin.	376
1.578	1.60	1.54	*Fichtelite*	$C_{18}H_{32}$	001. Y=*b*	Z∧*c*=+13°. 2V=87°	18
1.578	1.601	1.544	*Kroehnkite*	Sul.	010⊥Y	X∧*c*=−49°; 2V=79°. Blue	112
1.578	1.582	1.571	**ANORTHITE**	Sil.	001, 010	2V=80°±. Lam. twin.	378
1.579	1.583	1.578	*Bavenite*	Sil.	010⊥Z	X∧*a*=2°. 2V=47°	438
1.58	.016±		*Barrandite*	Phos.	Z ‖ fib.	2V=Mod.	140
1.58	Weak		*Calcioferrite*	Phos.	001⊥X±	2V=0°±. Yellow, green	156

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g or N_g-N_p	N_p	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
	1.545	1.545	1.525	Vermiculite	Sil.	001⊥X	2V=Sm. Yellow: X<Y	434
	1.55	.01±		**Antigorite**	Sil.	001⊥X	X=yellow, Z=green	280
	1.56	Very weak		**Penninite**	Sil.	001⊥X	2V=Sm. Green: X<Z	281
	1.56	.03±		**Zinnwaldite**	Sil.	001⊥X±	Z=*b*. 2V=35°±. Brown: X<Z	270
	1.56	1.56	1.53	*Nepouite*	Sil.	001⊥X±	2V=0°±. X=green, Z=yellow	279
	1.564	1.565	1.535	**Phlogopite**	Sil.	001⊥X±	Y=*b*. 2V=10°±. G.=2.75	272
	1.565	1.570	1.550	*Variscite*	Phos.	?	G.=2.54. Sol. HCl	140
	1.568	1.568	1.564	Beryl	Sil.	X=*c*	Also biax. Pneumat.	212
	1.57	1.570	1.545	Mizzonite	Sil.	100. X=*c*	Tet. Incl. common	297
1.57		Very weak		**Penninite**	Sil.	001⊥Z	2V=Sm. Green: X>Z	281
1.57		.006±		**Clinochlore**	Sil.	001⊥Z	2V=Sm. Green: X>Z	379
	1.575	1.577	1.553	*Autunite*	Phos.	001⊥X. Y=*b*	2V=33°. Yellow: X<Z	146
	1.575	.04±		**Talc**	Sil.	001⊥X. Z=*b*	2V=20°±. Insol.	262
	1.578	1.582	1.571	**ANORTHITE**	Sil.	001, 010	2V=80°±. Lam. twin.	378
1.58		1.615	1.540	*Hambergite*	Bor.	010⊥Y. X=*a*	G.=2.35. H.=7.5	91
	1.58	.01±		**Antigorite**	Sil.	001⊥X	X=yellow, Z=green	280
	1.58	1.59	1.55	*Jezekite*	Phos.	100. Y=*b*	X∧*c*=+29°. 2V=Mod.	158
	1.58	1.582	1.562	*Canbyite*	Sil.	One ⊥ Z	2V=Sm.	415
1.580		1.588	1.580	*Ceruleolactite*	Phos.	Z ∥ fib.	2V=0°. Sol. HCl	143
1.58		1.597	1.576	*Cookeite*	Sil.	001⊥Z	2V=40°±. G.=2.67	435
1.58		.015±		Amesite	Sil.	001⊥Z	2V=Sm. Ps. Hex.	285
1.580		1.640	1.580	*Cacoxenite*	Phos.	Z=*c*	2V=0°. Yellow: X<Z	143
1.58		.01±		Corundophilite	Sil.	001⊥X	2V=Sm. Green: X<Z	283
	1.582	1.587	1.56	*Uranospinite*	Phos.	001⊥X	2V=46°. Also biax. Yel: X<Z	147
	1.582±	.008		*Hopeite*	Phos.	100⊥Z?	2V=0°±. G.=3	124

1.582	1.588	1.552	**MUSCOVITE**	Sil.	001 ⊥ X	Z = *b*. 2V = 47°	267
1.583	1.602	1.583	*Alumianite*	Sul.	?	Rhom. Sol. HCl	107
1.583	1.593	1.583	*Xonotlite*	Sil.	Z ‖ fib.	X = *b*. 2V = Sm.	409
1.584	1.589	1.576	**ANORTHITE**	Sil.	001, 010	2V = 80° ±. Lam. twin.	378
1.585	1.656	1.585	*Cacoxenite*	Phos.	Z = *c*	2V = 0°. Yellow: X < Z	143
1.585	.01		*Natroalunite*	Sul.	001 ⊥ Z	G. = 2.6	114
1.585	1.585	1.576	*Metazeunerite*	Phos.	001 ⊥ X	2V = 0° ±. Green: X < Z	146
1.585	1.585	1.337	*Nitratite*	$NaNO_3$	10$\bar{1}$1. X = *c*	Rhom. G. = 2.27. Sol. H_2O	89
1.585	Mod.		*Volchonskoite*	Sil.	001 ⊥ X ±?	Green. Gel. HCl	416
1.585	1.585	1.560	*Nontronite*	Sil.	001 ⊥ X ±	Z ‖ fib. X = yellow, Z = green	415
1.586	1.586	1.560	*Uranospinite*	Phos.	001 ⊥ X	Ps. Tet. Yellow: X < Z	147
1.587	1.610	1.582	*Colemanite*	Bor.	010 ⊥ X	Z∧*c* = 83°. 2V = 55°	93
1.587	1.613	1.52	*Lanthanite*	Carb.	001 ⊥ X	Y = *a*. 2V = 62°	86
1.588	1.600	1.552	Pyrophyllite	Sil.	001 ⊥ X	2V = 55° ±	263
1.588	1.588	1.578	*Metavoltine*	Sul.	0001 ⊥ X?	Hex. Yellow: X < Z	114
1.588	1.594	1.583	**Celsian**	Sil.	001; 010	Y = *b*. Z∧*a* = 28°. 2V = 86°	359
1.589	Very weak		*Rinneite*	Hal.	10$\bar{1}$0	Z = *c*. G. = 2.35. Sol. H_2O	33
1.589	1.594	1.583	*Pharmacolite*	Phos.	010 ⊥ Z	X∧*c* = +70°. 2V = 79°	123
1.59	Weak		**Clinochlore**	Sil.	001 ⊥ Z	Y = *b*. 2E = Sm. Green: X > Z	283
1.59	.01 ±		Corundophilite	Sil.	001 ⊥ Z	Y = *b*. 2E = 50° ±. Green: X > Z	283
1.59	1.59	1.56	Vermiculite	Sil.	001 ⊥ X	2V = Sm. Brown: X < Z	434
1.59	1.590	1.545	**Talc**	Sil.	001 ⊥ X. Z = *b*	2V = 20° ±. Insol.	262
1.59	1.59	1.555	**Phlogopite**	Sil.	001 ⊥ X; Y = *b*	2V = 10° ±. Yellow: X < Z	366
1.59	.03 ±		**Zinnwaldite**	Sil.	001 ⊥ X; Z = *b*	2V = 35° ±. Brown: X < Z	270
1.59	Very weak		**Penninite**	Sil.	001 ⊥ X; Y = *b*	2V = 0° ±. Green: X < Z	281
1.59 ±	Weak		*Nouméite*	Sil.	Z ‖ fib.	2E = Sm. Green	261
1.59	1.598	1.586	*Custerite*	Sil.	001	X = *b*. Z∧*c* = 6°. 2E = 105°	412
1.59	Very weak		*Chlormankalite*	Hal.	Z = *c*	Rhom. Yellow. Sol. H_2O	33
1.59	1.605	1.575	*Catapleite*	Sil.	X = *c*; Y = *b*	2V = Lg.	400
1.59	1.59	1.56	*Connarite*	Sil.	001 ⊥ X	2V = 0° ±. Green; pleo.	280
1.59 ±	.01 ±		*Jenkinsite*	Sil.	001 ⊥ X	2V = Mod. Green	281

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g (or N_g-N_p)	N_p	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
	1.56	1.56	1.53	*Nepouite*	Sil.	001 ⊥ X±	2V=0°±. X=green, Z=yel.	279
	1.565	1.570	1.550	*Variscite*	Phos.	?	G.=2.54. Sol. HCl	140
	1.568	1.568	1.564	Beryl	Sil.	X=*c*	Also biax. Pneumat.	212
	1.57	1.570	1.545	Mizzonite	Sil.	100. X=*c*	Tet. Incl. common	297
1.57		Very weak		**Penninite**	Sil.	001 ⊥ Z	2V=Sm. Green: X>Z	281
	1.575	1.577	1.553	*Autunite*	Phos.	001 ⊥ X. Y=*b*	2V=33°. Yellow: X<Z	146
1.58		.015±		Amesite	Sil.	001 ⊥ Z	2V=Sm. Ps. Hex.	285
1.58		1.615	1.540	*Hambergite*	Bor.	010 ⊥ Y. X=*a*	G.=2.35. H.=7.5	91
	1.582	1.588	1.552	**MUSCOVITE**	Sil.	001 ⊥ X	Z=*b*. 2V=47°	267
	1.585	1.585	1.560	*Nontronite*	Sil.	001 ⊥ X±	Z ∥ fib. X=yellow, Z=green	415
1.587		1.610	1.582	*Colemanite*	Bor.	010 ⊥ X	Z∧*c*=83°. 2V=55°	93
1.588		1.594	1.583	**Celsian**	Sil.	001; 010	Y=*b*. Z∧*a*=28°. 2V=86°±	359
	1.59±	1.590	1.587	*Kaemmererite*	Sil.	001 ⊥ X	2V=Sm. Purple: X<Z	286
1.59		1.597	1.584	**Anthophyllite**	Sil.	110 at 56°	Y=*b*. Z=*c*. 2V=85°±	240
1.59		1.597	1.584	*Kupfferite*	Sil.	110 at 56°	Y=*b*. Z∧*c*=11°. 2V=85°±. Green	244
1.59		Weak		Prochlorite	Sil.	001 ⊥ Z	Y=*b*. 2V=Sm. Green: X>Z	284
1.59		.02		*Martinite*	Phos.	Y=*b*; Z=*a*	2V=Lg. Sol. HCl	124
	1.59	1.59	1.555	**BIOTITE**	Sil.	001 ⊥ X; Y=*b*	2V=0°±. Brown or green: X<Z	272
	1.59	1.59	1.54	Leverrierite	Sil.	001 ⊥ X±	Y=*b*; 2V=50°±	433
	1.59	.04±		*Protolithionite*	Sil.	001 ⊥ X±	2V=0°±. X=yel. Z=brown	270
	1.59	.04±		Phengite	Sil.	001 ⊥ X±	2V=Sm.	267
	1.59	Very weak		Delessite	Sil.	001 ⊥ X	2V=Sm. Green: X<Z	282
1.591		1.631	1.559	*Hambergite*	Bor.	010 ⊥ Y; X=*a*	2V=87°. G.=2.35	91
	1.591	1.59+	1.572	*Hopeite*	Phos.	100 ⊥ Z; X=*b*	2V=36°	124
	1.591	1.591	1.573	*Metavoltine*	Sul.	0001 ⊥ X?	2V=0°. Yellow; X<Z	114
	1.591	1.594	1.572	*Priceite*	Bor.	001, 110	2V=32°	93

1.592	1.627	1.591	*Catapleite*	Sil.	110 at 60°±	Y=*b*; Z=*c*±. 2V=Sm.	400
1.592	1.614	1.586	*Colemanite*	Bor.	010⊥X	Z∧*c*=83°. 2V=55°	93
1.592	1.611	1.572	*Johannite*	Sul.	001, 011	X=*b*±. Tr. 2V=Lg.	118
1.592	1.592	1.582	*Torbernite*	Phos.	001⊥X	2V=0°±. X=green, Z=yel.	145
1.593	1.600	1.587	**Celsian**	Sil.	001, 010	Y=*b*; Z∧*a*=28°. 2V=Lg.	359
1.593±	1.598	1.578	Amblygonite	Phos.	001, 100	Tr. 2V=50°±	152
1.593	1.593	1.563	*Ganophyllite*	Sil.	001⊥X±	Z=*b*. 2V=Sm.	436
1.593	1.594	1.558	*Kryptotile*	Sil.	001⊥X	Y=*b*. 2V=Sm.	421
1.594	1.598	1.594	*Foshagite*	Sil.	Z ‖ fib.	2V=Sm. Gel. HCl	408
1.594	1.597	1.570	*Astrolite*	Sil.	One⊥X	2V=30°	429
1.595	1.610	1.575	*Variscite*	Phos.	?	2V=55°±. Sol. HCl	140
1.595	1.602	1.590	*Cuspidine*	Sil.	001; Y=*b*	Z∧*c*=6°. 2E=110°	412
1.595	1.62	1.57	*Szmikite*	Sul.	One; Z=*b*	2V=Lg. Sol. H_2O	104
1.595	Strong		*Fuchsite*	Sil.	001⊥X	2E=70°±. Green: X<Z	269
1.595	1.595	1.585	*Crandallite*	Phos.	X=*c*	Fibrous. Rare	154
1.595	1.598	1.571	*Leucophane*	Sil.	001⊥X. 100⊥Y	2V=39°. G.=2.96	210
1.596	.024±		*Autunite*	Phos.	001⊥X. Y=*b*	2V=33°. Yellow: X<Z	146
1.597	1.616	1.577	*Johannite*	Sul.	001, 011	X=*b*±. Tr. 2V=Lg.	118
1.597	1.598	1.575	Chrysocolla	Sil.	?	2V=Sm. Blue: X>Z	411
1.598	1.605	1.586	*Howlite*	Bor.	Z∧*c*=44°±	X=*b*. 2V=Lg.	95
1.598	1.627	1.580	Vivianite	Phos.	010⊥X	Z∧*c*=28°. X=blue, Z=olive	126
1.598	1.598	1.592	*Dahllite*	Phos.	Z ‖ fib.	X=*c*. Sol. HCl	161
1.60	1.60	1.56	Mizzonite	Sil.	100. X=*c*	Tet. Incl. common	297
1.60	1.60	1.56	Leverrierite	Sil.	001⊥X±	Y=*b*. 2V=50°±	433
1.6±	.025±		Bowlingite	Sil.	001⊥X±	2E=Sm. X=yel. Z=green	437
1.60	1.628	1.595	*Cebollite*	Sil.	Ext. ‖ fib.	2V=58°. Gel. HCl	431
1.6±	.014		*Manandonite*	Bor.	001⊥Z	2E=25°–30°	95
1.600	1.602	1.586	*Spencerite*	Phos.	100⊥X±. 010	Z=*b*. 2V=49°. Lam. twin.	137
1.60±	1.603	1.595	*Riversidite*	Sil.	Z ‖ fib.	G.=2.61	409

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g	N_p (or $N_g - N_p$)	Mineral	Chem.	Cleavage Opt. Orient.	Other Characters	Page
	1.56	1.56	1.53	*Nepouite*	Sil.	001 ⊥ X ±	2V = 0° ±. X = green, Z = yel.	279
	1.568	1.568	1.564	Beryl	Sil.	X = *c*	Also biax. Pneumat.	212
1.57		Very weak		**Penninite**	Sil.	001 ⊥ Z	2V = Sm. Green: X > Z	281
1.58		.015 ±		Amesite	Sil.	001 ⊥ Z	2V = Sm. Ps. Hex.	285
	1.582	1.588	1.552	**MUSCOVITE**	Sil.	001 ⊥ X	Z = *b*. 2V = 47°	267
	1.585	1.585	1.560	*Nontronite*	Sil.	001 ⊥ X ±	Z ‖ fib. X = yellow, Z = green	415
1.59		1.597	1.584	**Anthophyllite**	Sil.	110 at 56°	Y = *b*. Z = *c*. 2V = 85° ±	240
1.59		1.597	1.584	*Kupfferite*	Sil.	110 at 56°. Y = *b*	Z ∧ *c* = 11°. 2V = 85° ±. Green	244
1.59		Weak		Prochlorite	Sil.	001 ⊥ Z	Y = *b*. 2V = Sm. Green: X > Z	284
1.59		.02		*Martinite*	Phos.	Y = *b*; Z = *a* ±	2V = Lg. Sol. HCl	124
	1.59	1.59	1.555	**BIOTITE**	Sil.	001 ⊥ X. Y = *b*	2V = 0° ±. Br. or gr.: X < Z	272
	1.59	.04 ±		*Protolithionite*	Sil.	001 ⊥ X ±	2V = 0° ±. X = yel., Z = br.	270
	1.59	.04 ±		Phengite	Sil.	001 ⊥ X ±	2V = Sm.	267
	1.59	Very weak		Delessite	Sil.	001 ⊥ X ±	2V = Sm. Green: X < Z	282
	1.593	1.593	1.563	*Ganophyllite*	Sil.	001 ⊥ X	Z = *b*. 2V = Sm.	436
1.598		1.627	1.580	Vivianite	Phos.	010 ⊥ X	Z ∧ *c* = 28°. X = blue, Z = olive	126
	1.598	1.598	1.592	*Dahllite*	Phos.	Z ‖ fib.	X = *c*. Sol. HCl	161
	1.60	1.60	1.56	Meionite	Sil.	100. X = *c*	Tet. Dec. HCl	297
	1.602	1.602	1.595	Beryl	Sil.	X = *c*	G. = 2.9. Insol.	212
1.602		1.638	1.590	*Haidingerite*	Phos.	010 ⊥ X	2V = 58°. G. = 2.85	123
1.603		1.615	1.594	*Fremontite*	Phos.	001 ⊥ X ±	Tr.? 2V = Lg.	152
	1.603	1.607	1.593	*Crestmorite*	Sil.	100? Z ∧ *c* = 12°	2V = Lg.	409
	1.603	1.611	1.584	*Bertrandite*	Sil.	001 ⊥ Z. X = *a*	2V = 74°	410
	1.604	1.636	1.582	Vivianite	Phos.	010 ⊥ X	Z ∧ *c* = 28°. X = blue, Z = olive	126
	1.605	1.611	1.51	*Amarantite*	Sul.	100 ⊥ X ±; 010	Y = *b*. 2E = 60°. Yel.: X < Z	109
1.606		.02		*Martinite*	Phos.	Y = *b*. Z = *a* ±	Mon.? 2V = Lg.	124
1.606 ±		1.608	1.606	*Eudialite*	Sil.	0001 ⊥ Z	Yellow, etc. X < Z	417

1.606±	1.633	1.595	Pectolite	Sil.	100⊥X±; 001	Y=*c*. 2V=60°	419
1.606	1.622	1.593	Chondrodite[1]	Sil.	X∧*a*=26°±	Z=*b*. 2V=80°±	196
1.607	Weak		*Eucolite*	Sil.	0001⊥X	Yellow, etc. X>Z	417
1.608	.03		*Ganophyllite*	Sil.	001⊥X±; 010	Z=*b*. 2V=Sm. Yel.: X>Z	436
1.609	.025±		Glauconite	Sil.	001⊥X±	2V=Sm. Green: X<Z	436
1.61	Very weak		**Penninite**	Sil.	001⊥Z±	2V=Sm. Green: X>Z	281
1.61	.015±		Amesite	Sil.	001⊥Z±	2V=Sm. G.=2.8	285
1.61	1.613	1.610	*Eudialite*	Sil.	0001⊥Z	Yellow, etc. X<Z	417
1.61	.04±		**MUSCOVITE**	Sil.	001⊥X±	2V=45°±	267
1.61	.04±		Phengite	Sil.	001⊥X±	2V=Sm.	267
1.61	Very weak		Delessite	Sil.	001⊥X±	2V=Sm. Green: X<Z	282
1.61±	1.612	1.605	*Hillebrandite*	Sil.	110	Z=*c*. 2E=70°±. Sol. HCl.	408
1.61	Very weak		Ripidolite	Sil.	001⊥Z±	2V=Sm. Green: X>Z	284
1.61	1.617	1.607	Topaz	Sil.	001⊥Z	2V=65±°. G.=3.5	198
1.61	Very weak		*Metatorbernite*	Phos.	001⊥Z±	2V=Sm. X=blue, Z=green	145
1.61	Weak		Diabantite	Sil.	001⊥X±	2V=Sm. Green: X<Z	283
1.611	1.651	1.610	*Pseudowollast.*	Sil.	001⊥Z±	2V=Sm. G.=2.905	402
1.612	1.621	1.592	*Herderite*	Phos.	Z∧*c*=−3°	Y=*b*. 2V=74°	134
1.612	1.612	1.607	*Fluocerite*	Hal.	0001⊥X	G.=6. Yellow	33
1.613	1.619	1.609	*Stokesite*	Sil.	110 at 38°	X=*a*. Y=*b*. 2V=70°	409
1.613	1.649	1.602	*Anapaite*	Phos.	101, 010	Tr. 2V=53°	128
1.613	1.613	1.593	*Meliphanite*	Sil.	001⊥X	Tet. Yellow: X<Z	210
1.613	1.624	1.600	**Tremolite**	Sil.	110 at 56°	Y=*b*. Z∧*c*=17°. 2V=85°	245
1.614	1.630	1.607	*Montebrazite*	Phos.	001, 100	2V=80°±. G.=3±	152
1.614	Weak		*Francolite*	Phos.	X=*c*	Also biax. G.=3.1	161
1.614	1.616	1.594	*Phosphophyllite*	Phos.	100, 010	Y∧*a*=50°. Z=*b*. 2V=50°±	125
1.615	1.615	1.575	Meionite	Sil.	100. X=*c*	G.=2.8	297
1.617	1.636	1.614	Hemimorphite	Sil.	110 at 76°	X=*b*. Z=*c*. 2V=46°	211
1.617	1.655	1.588	*Kyanotrichite*	Sul.	X=*a*; Z=*c*	2V=83°. Blue: X<Z	116
1.618	.02		*Fremontite*	Phos.	001⊥X±	Tr.? 2V=Lg.	152
1.618	1.618	1.611	*Fluocerite*	Hal.	0001⊥X	G.=6. Yellow	33

[1] E. S. Larsen: *Am. Mineral.*, XIII, 1928, p. 354.

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g	N_p (or $N_g - N_p$)	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
	1.56	1.56	1.53	*Nepouite*	Sil.	001 ⊥ X±	2V = 0°±. X = gr., Z = yel.	279
	1.585	1.585	1.560	*Nontronite*	Sil.	001 ⊥ X±	Z ‖ fib. X = yel., Z = green	415
1.59		1.597	1.584	**Anthophyllite**	Sil.	110 at 56°	Y = *b*. Z = *c*. 2V = 85°±	240
1.59		1.597	1.584	*Kupfferite*	Sil.	110 at 56°. Y = *b*	Z∧*c* = 11°. 2V = 85°±. Gr.	244
1.59		Weak		Prochlorite	Sil.	001 ⊥ Z. Y = *b*	2V = Sm. Green: X > Z	284
	1.59	1.59	1.555	**BIOTITE**	Sil.	001 ⊥ X. Y = *b*	2V = 0°±. Br. or gr.: X < Z	272
	1.59	.04±		*Protolithionite*	Sil.	001 ⊥ X±	2V = 0°±. X = yel., Z = br.	270
	1.598	1.598	1.592	*Dahllite*	Phos.	Z ‖ fib.	X = *c*. Sol. HCl	161
1.606		1.622	1.593	Chondrodite	Sil.	X∧*a* = 26°±	Z = *b*. 2V = 80°±	196
	1.607	Weak		*Eucolite*	Sil.	0001 ⊥ X	Yellow, etc.: X > Z	417
	1.609	.025±		Glauconite	Sil.	001 ⊥ X±	2V = Sm. Green: X < Z	436
1.61		Very weak		Ripidolite	Sil.	001 ⊥ Z±	2V = Sm. Green: X > Z	284
1.61		1.617	1.607	Topaz	Sil.	001 ⊥ Z	2V = 65°. G. = 3.5	198
1.61		Very weak		*Metatorbernite*	Phos.	001 ⊥ Z±	2V = Sm. X = blue, Z = green	145
	1.61	Very weak		Diabantite	Sil.	001 ⊥ X±	2V = Sm. Green: X < Z	283
	1.613	1.624	1 600	**Tremolite**	Sil.	110 at 56°. Y = *b*	Z∧*c* = 17°. 2V = 85°±	245
	1.614	Weak		*Francolite*	Phos.	X = *c*	Also biax. G. = 3.1	161
1.618		1.633	1.613	**Pargasite**	Sil.	110 at 56°	Y = *b*. Z∧*c* = 25°±. 2V = 60°± Yellow, green: X < Z	248
	1.618	1.618	1.552	*Chalcophyllite*	Phos.	0001 ⊥ X	G. = 2.5. Green	136
1.62		Weak		Prochlorite	Sil.	001 ⊥ Z±	2V = Sm. Green: X > Z	284
1.62		1.63	1.61	*Kupfferite*	Sil.	110 at 56°	Z∧*c* = 12°±. 2V = 80°±. Yel., green: X < Z	244
1.62		1.65	1.61	*Turquois*	Phos.	1$\bar{1}$0. Tric.	2V = 40°. Blue; pleo.	157
1.62		1.654	1.620	*Churchite*	Phos.	One ⊥ Z	2V = 0°±. Sol. HCl	156
	1.62	1.649	1.575	*Camsellite*	Bor.	X ‖ elong.	2V = Lg.	91
1.620		1.637	1.617	*Afwillite*	Sil.	001; Y = *b*	X∧*c* = 30°. 2V = 55°	412
	1.62	.02±		*Kreuzbergite*	Phos.	010?	Y = *c*? 2V = 90°±	141

1.620	1.630	1.620	*Goyazite*	Phos.	0001⊥Z	Brown: X>Z	153
1.62	1.63	1.61	Cummingtonite	Sil.	110 at 55°	Y=*b*. Z∧*c*=15°±. 2V=90°± Yellow: X<Z	243
1.620	.015±		**Wollastonite**	Sil.	100, 001	X∧*c*=32°. Y=*b*. 2V=40°±	401
1.621	1.621	1.619	*Gillespite*	Sil.	0001⊥X	Hex.? Red: X>Z	401
1.622	1.658	1.618	*Arakawaite*	Phos.	Z∧*c*=−36°	2V=38°. Green	138
1.623	1.631	1.622	Celestite	Sul.	001, 110, 010	X=*c*. 2V=51°. G.=4.0	99
1.623	1.631	1.621	*Uranopilite*	Sul.	X⊥lath.±	2V=Sm. Yellow	117
1.623	1.623	1.610	*Uranocircite*	Phos.	001⊥X	2V=10°. Yellow: X<Z	147
1.623	1.623	1.620	*Merrillite*	Phos.	10$\bar{1}$0. X=*c*	Also biax. +?	149
1.623	1.623	1.602	*Bazzite*	Sil.	X=*c*	Hex. X=blue, Z=yellow	414
1.624	1.645	1.615	Prehnite	Sil.	001⊥Z	X=*a*. 2V=66°±. Sol. HCl	430
1.624	1.652	1.617	Humite	Sil.	X=*a*; Z=*b*	2V=68°. Yellow: X>Z	197
1.625	1.71	1.615	*Bisbeeite*	Sil.	Z ‖ elong.	2V=Sm. Colorless or X=brown, Z=green	411
1.625	Weak		*Gorceixite*	Phos.	Rhom.?	G.=3.1	153
1.625	1.665	1.615	*Destinezite*	Sul.	Z∧elong.=16°	2V=Sm.	121
1.625	1.637	1.614	*Parahopeite*	Phos.	010; X=*a*±	Tr. 2V=90°±	128
1.625	.025±		**Tremolite**	Sil.	110 at 56°	Y=*b*. Z∧*c*=15°. 2V=85°±	245
1.625	Strong		*Roscherite*	Phos.	001; 010⊥X	2V=Lg. X=green, Z=br.	156
1.625	.025±		**Actinolite**	Sil.	110 at 56°	Y=*b*. Z∧*c*=15°. 2V=85°±. X=yellow, Z=green	245
1.626	1.626	1.608	*Bazzite*	Sil.	X=*c*	Hex. X=blue, Z=yellow	414
1.627	Weak		*Francolite*	Phos.	X=*c*	Also biax. Sol. HCl	161
1.627	1.627	1.582	*Troegerite*	Phos.	001⊥X	Also biax. Yellow	147
1.628	Weak		*Metatorbernite*	Phos.	001⊥Z	Abn. int. colors	145
1.629	1.639	1.629	*Goyazite*	Phos.	0001⊥Z	Colorless or brown: X>Z	153
1.629	1.630	1.620	*Margarite*	Sil.	001⊥X±	2V=Sm.−67°. G.=3	288
1.63	Very weak		Ripidolite	Sil.	001⊥Z±	2V=Sm. Green: X>Z	284
1.63	Very weak		Diabantite	Sil.	001⊥X±	2V=Sm. Green: X<Z	283
1.63	.037		*Nepouite*	Sil.	001⊥X±	2V=Sm. Green: X<Z	279
1.63±	1.635	1.629	*Fibrolite*	Sil.	010⊥X	2V=30°±. Fibrous	200

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g	N_p (or N_g-N_p)	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
	1.585	1.585	1.560	*Nontronite*	Sil.	001 ⊥ X±	Z ∥ fib. X = yel., Z = green	415
1.59		1.597	1.584	**Anthophyllite**	Sil.	110 at 56°	Y = *b*. Z = *c*. 2V = 85° ±	240
	1.59	1.59	1.555	**BIOTITE**	Sil.	001 ⊥ X. Y = *b*	2V = 0° ±. Br. or gr.: X < Z	272
	1.59	.04 ±		*Protolithionite*	Sil.	001 ⊥ X±	2V = 0° ±. X = yel., Z = br.	270
	1.598	1.598	1.592	*Dahllite*	Phos.	Z ∥ fib.	X = *c*. Sol. HCl	161
1.606		1.622	1.593	Chondrodite	Sil.	X ∧ *a* = 26° ±	Z = *b*. 2V = 80° ±	196
	1.607	Weak		*Eucolite*	Sil.	0001 ⊥ X	Yellow, etc. X > Z	417
	1.609	.025 ±		Glauconite	Sil.	001 ⊥ X±	2V = Sm. Green: X < Z	436
1.61		1.617	1.607	Topaz	Sil.	001 ⊥ Z	2V = 65. G. = 3.5	198
1.618		1.633	1.613	**Pargasite**	Sil.	110 at 56°	Z ∧ *c* = 25° ±. 2V = 60° ±. Yellow, green: X < Z	248
	1.618	1.618	1.552	*Chalcophyllite*	Phos.	0001 ⊥ X	G. = 2.5. Green	136
1.62		1.63	1.61	Cummingtonite	Sil.	110 at 55°	Y = *b*. Z ∧ *c* = 15° ±. 2V = 90° ±. Yellow: X < Z	243
	1.620	.015 ±		**Wollastonite**	Sil.	100, 001	X ∧ *c* = 32°. Y = *b*. 2V = 40°	401
1.624		1.645	1.615	Prehnite	Sil.	001 ⊥ Z	X = *a*. 2V = 66° ±. Sol. HCl	430
1.624		1 652	1.617	Humite	Sil.	X = *a*. Z = *b*	2V = 68°. Yellow: X > Z	197
	1.625	.025 ±		**Actinolite**	Sil.	110 at 56°	Z ∧ *c* = 15°. 2V = 80° ±. X = yellow, Z = green	245
	1.629	1.630	1.620	*Margarite*	Sil.	001 ⊥ X±	2V = Sm. −67°. G. = 3	288
	1.630	1.630	1.585	*Troegerite*	Phos.	010 ⊥ X	2V = Sm. Yellow	147
	1.63	1.638	1.625	Celadonite	Sil.	001 ⊥ X±	2V = Sm. Green: X < Z	436
	1.63	.02 ±		*Bityite*	Sil.	001 ⊥ X	Ps. Hex. 2V = Sm.	427
	1.63	1.64	1.62	*Carpholite*	Sil.	010 ⊥ X	Z = *c*. 2V = 60° ±. Yellow: X > Z	431
	1.63	.09 ±		*Stilpnomelane*	Sil.	001 ⊥ X±	2V = Sm. Gr. or br.: X < Z	435
	1.63	.02 ±		**Tourmaline (Mg)**	Sil.	X = *c*	Colorless or brown: X < Z. Insol.	301
	1.63	Very weak		Aphrosiderite	Sil.	001 ⊥ X±	2V = Sm. Green: X < Z	284
1.631		1.638	1.629	Topaz	Sil.	001 ⊥ Z	2V = 48°. G. = 3.55	198
	1.632	1.632	1.575	*Chalcophyllite*	Phos.	0001 ⊥ X	G. = 2.5. Green	136

1.632	1.640	1.631	*Picropharmacolite*	Phos.	010 ⊥ Y; 100	$X \wedge c = 37°$. $2V = 40°$	125
1.632	1.639	1.603	Lazulite	Phos.	$X \wedge c = -9°$	$Y = b$. $2V = 69°$. Blue: X<Z	154
1.632	1.632	1.630	**Apatite (F)**	Phos.	$X = c$	White or tinted: X>Z	129
1.632	1.632	1.602	*Bementite*	Sil.	001 ⊥ X	$Y = b$. $2V = 0° \pm$. Yellow: X<Z	409
1.633	1.635	1.621	**Wollastonite**	Sil.	100, 001	$X \wedge c = 32°$. $Y = b$. $2V = 40° \pm$	401
1.633	1.639	1.629	**Andalusite**	Sil.	110 at 89°	$X = c$. $2V = 84°$. Red±: X>Z	201
1.633	1.639	1.633	**Akermanite**	Sil.	110 at 90°	$Z = c$. Tet. Gel. HCl	209
1.633	1.636	1.630	*Danburite*	Sil.	$X = b$. $Y = c$	$2V = 88° \pm$	210
1.634	1.634	1.627	*Dahllite*	Phos.	Z ‖ fib.	$X = c$. Sol. HCl	161
1.635	.04		*Protolithionite*	Sil.	001 ⊥ X±	$2V = 0° \pm$. Brown: X<Z	270
1.635	1.657	1.613	*Sklodowskite*	Sil.	001 ⊥ Y	2V = Lg. Yellow: X<Z	441
1.635	1.635	1.615	Tourmaline (Li)	Sil.	$X = c$	Colorless or X<Z. Insol.	301
1.636±	1.644	1.623	*Gedrite*	Sil.	110 at 56°	$X = a$; $Z = c$. $2V = 79°$. Insol.	240
1.636	1.660	1.631	*Schizolite*	Sil.	100 ⊥ Y±; 001	Tr. $2E = 83°$	420
1.636	1.639	1.602	*Grandidierite*	Sil.	100 ⊥ X; 010 ⊥ Z	$2V = 30°$. Blue: Y<Z	421
1.636	1.644	1.609	*Inesite*	Sil.	010 ⊥ X±; 100	$2V = 60°$. Pink; pleo.	413
1.637	.006		*Danburite*	Sil.	$X = b$; $Y = c$	$2V = 88° \pm$	210
1.637	1.648	1.636	Barite	Sul.	001, 110	$X = c$. $2V = 38°$. Insol.	100
1.637	1.637	1.581	*Ekmannite*	Sil.	X ⊥ 001±	Brown: X<Z	281
1.638±	1.639	1.621	Glaucophane	Sil.	110 at 56°	$Z \wedge c = 5° \pm$. $2V = 45° \pm$. Blue: X<Z	258
1.64	1.65	1.625	**Actinolite**	Sil.	110 at 56°	$Z \wedge c = 15° \pm$. $2V = 80° \pm$. X = yellow, Z = green	245
1.640	1.645	1.640	**Akermanite**	Sil.	110 at 90°	$Z = c$. Tet. Gel. HCl	209
1.64	.01		*Svanbergite*	Sul.	0001 ⊥ Z	Rhom. Also biax.	119
1.64	1.66	1.64	*Roeblingite*	Sil.	X ‖ fib.	2V = Sm. G. = 3.43	440
1.64	.02		*Barrandite*	Phos.	Z ‖ fib.	2V = Lg. G. = 2.6±	140
1.640	1.697	1.640	*Planchéite*	Sil.	Z ‖ fib.	$2V = 0°$? Blue: X<Z	411
1.64±	.01		*Chamosite*	Sil.	001 ⊥ X	2V = Sm. Green: X<Z	286
1.64	Mod.?		*Eremeyevite*	Bor.	Ps. Hex.	2V = Sm. G. = 3.28	94
1.64	.02±		**HORNBLENDE**	Sil.	110 at 56°	$Y = b$. $Z \wedge c = 20° \pm$. $2V = 80° \pm$. X = yellow, Z = green	247
1.64	.03±		**Tourmaline (Fe)**	Sil.	$X = c$	Brown, green, blue: X<Z	301
1.64	Weak		**Melilite**	Sil.	X or Z = c	Abn. int. colors	208

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g	N_p (or N_g-N_p)	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
	1.585	1.585	1.560	*Nontronite*	Sil.	001 ⊥ X±	Z ∥ fib. X = yel., Z = green	415
1.59		1.597	1.584	**Anthophyllite**	Sil.	110 at 56°	Y = *b*. Z = *c*. 2V = 85° ±	240
	1.59	1.59	1.555	**BIOTITE**	Sil.	001 ⊥ X. Y = *b*	2V = 0° ±. Br. or gr.: X < Z	272
1.606		1.622	1.593	Chondrodite	Sil.	X ∧ *a* = 26° ±	Z = ***b***. 2V = 80° ±	196
	1.607	Weak		*Eucolite*	Sil.	0001 ⊥ X	Yellow, etc.: X > Z	417
	1.609	.025±		Glauconite	Sil.	001 ⊥ X±	2V = Sm. Green: X < Z	436
1.618		1.633	1.613	**Pargasite**	Sil.	110 at 56°	Z∧*c* = 25° ±. 2V = 60° ±. Yellow, green: X < Z	248
1.62		1.63	1.61	Cummingtonite	Sil.	110 at 55°	Z∧*c* = 15° ±. 2V = 90° ±. Yellow: X < Z	243
1.624		1.645	1.615	Prehnite	Sil.	001 ⊥ Z	X = *a*. 2V = 66° ±. Sol. HCl	430
1.624		1.652	1.617	Humite	Sil.	X = *a*. Z = *b*	2V = 68°. Yellow: X > Z	197
	1.629	1.630	1.620	*Margarite*	Sil.	001 ⊥ X±	2V = Sm. −67°. G. = 3	288
	1.63	.09±		*Stilpnomelane*	Sil.	001 ⊥ X±	2V = Sm. Gr. or br.: X < Z	435
	1.63	.02±		**Tourmaline (Mg)**	Sil.	X = *c*	Colorless or brown: X < Z. Insol.	301
	1.63	Very weak		Aphrosiderite	Sil.	001 ⊥ X±	2V = Sm. Green: X < Z	284
	1.632	1.632	1.630	**Apatite (F)**	Phos.	X = *c*	Colorless or tinted: X < Z	128
	1.632	1.632	1.602	*Bementite*	Sil.	001 ⊥ X	Y = *b*. 2V = 0° ±. Yellow: X < Z.	409
	1.633	1.639	1.629	**Andalusite**	Sil.	110 at 89°	X = *c*. 2V = 84°. Red ±: X > Z	201
	1.635	1.635	1.615	Tourmaline (Li)	Sil.	X = *c*	Colorless or tinted: X < Z	301
	1.64	.02±		**HORNBLENDE**	Sil.	110 at 56°	Y = *b*. Z∧*c* = 20° ±. 2V = 80° ±. X = yellow, Z = green	247
	1.64	.03±		**Tourmaline (Fe)**	Sil.	X = *c*	Brown, green, blue: X < Z	301
1.64		Weak		**Melilite**	Sil.	X or Z = *c*	Abnor. int. colors	208
1.64		.02		*Barrandite*	Phos.	Z ∥ fib.	2V = Lg. G. = 2.6±	140
1.641		1.652	1.633	*Fairfieldite*	Phos.	010, 100	Tr Sol. HCl	127
	1.642	1.647	1.584	*Serpierite*	Sul.	001 ⊥ X	2V = 35°. Green: X < Z	102
1.642		1.665	1.632	Prehnite	Sil.	001 ⊥ Z	X = *a*. 2V = 65° ±. G. = 2.9	430
	1.643	1.645	1.632	*Margarite*	Sil.	001 ⊥ X	2V = Sm. G. = 3.0–3.1	288

1.643	1.643	1.634	*Eucolite*	Sil.	0001 ⊥ X	Colorless or X>Z	417
1.643	.035±		Humite	Sil.	X=*a*; Z=*b*	2V=68°±. Yel.±: X>Z	197
1.643	1.643	1.623	*Zeunerite*	Phos.	001 ⊥ X	2V=0°±. Green: X<Z	146
1.644	1.647	1.640	**Andalusite**	Sil.	110 at 89°	X=*c*; Z=*a*. 2V=85°. Colorless or X>Z	201
1.644	1.654	1.636	*Fairfieldite*	Phos.	010, 100	Tr. G.=3.1. Sol. HCl	127
1.644?	1.697	1.644	*Dioptase*	Sil.	10$\bar{1}$1. Z=c	Also biax. Green: X>Z	186
1.644	1.654	1.642	Mullite	Sil.	010 ⊥ Y; Z=*c*	2V=50°±. Pink±: X<Z	235
1.645	1.663	1.635	Chondrodite	Sil.	X∧*a*=26°; Z=*b*	2V=80°±. Yellow: X<Z	196
1.645	1.645	1.612	Glauconite	Sil.	001 ⊥ X±	2V=Sm. Green: X<Z	436
1.646	1.649	1.630	*Gastaldite*	Sil.	110 at 56°	Z∧*c*=6°±. 2V=43°±. G.=3.0–3.1	259
1.648	1.648	1.643	**Apatite (F)**	Phos.	X=*c*	Colorless or X>Z	128
1.648	1.674	1.643	*Reddingite*	Phos.	010 ⊥ Y; Z=*c*	2V=41°. Brown: X<Y	124
1.649	1.658	1.646	*Mosandrite*	Sil.	100 ⊥ Z±	2V=74°. Brown	423
1.649	1.660	1.585	*Herrengrundite*	Sul.	001, 110	X=*c*±. Z=*b*. 2V=39	104
1.65	Very weak		Aphrosiderite	Sil.	001 ⊥ X±	2V=Sm. Green: X<Z	284
1.65	1.65	1.63	Tourmaline (Li)	Sil.	X=*c*	Colorless or X>Z	301
1.65±	.03±		*Barrandite*	Phos.	Z ǁ fib.	2V=Sm. G.=3.43	140
1.65±	.01±		*Hellandite*	Sil.	Z∧*c*=−44°	X=*b*. 2V=80°±. Brown	425
1.65	1.655	1.625	*Nontronite*	Sil.	001 ⊥ X±	Z ǁ fib. X=yel., Z=green	415
1.65	1.65	1.624	*Bementite*	Sil.	001 ⊥ Z	Y=*b*. 2V=0°±. Yellow: X<Z	409
1.65	1.655	1.6c8	Iddingsite	Sil.	100 ⊥ X; 001 ⊥ Z	2V=40°±. Brown: X<Z	437
1.65	1.65	1.575	*Szaibelyite*	Bor.	Acicular	G.=2.76–3.0	92
1.650	1.682	1.610	*Epistolite*	Sil.	001 ⊥ Z±	Y=*b*. 2V=80°. G.=2.89	442
1.65	1.656	1.645	*Koninckite*	Phos.	X ǁ fib.	Yellow. Sol. HCl	142
1.65	.01		*Auerlite*	Ox.	Z=*c*	Tet. Yellow	185
1.65	1.65	1.62	*Friedelite*	Sil.	0001 ⊥ X	2V=0°±. Pink±	408
1.65	1.66	1.64	**Allanite**	Sil.	Y=*b*	2V=Lg. Green: X<Z	316
1.65	Very weak		**Apatite (Cl)**	Phos.	X=*c*	Colorless or X>Z	128
1.65	Very weak		Daphnite	Sil.	001 ⊥ X±	2V=0°±. Green: X<Z	285
1.65	.01±		Thuringite	Sil.	001 ⊥ X±	2V=0°±. Green: X<Z	285

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g or N_g-N_p	N_p	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.59		1.597	1.584	**Anthophyllite**	Sil.	110 at 56°	Y=*b*. Z=*c*. 2V=85°±	240
	1.59	1.59	1.555	**BIOTITE**	Sil.	001⊥X. Y=*b*	2V=0°±. Brown or green: X<Z	272
1.618		1.633	1.613	**Pargasite**	Sil.	110 at 56°	Z∧*c*=25°. 2V=60°±. Yellow, green: X<Z	248
1.62		1.63	1.61	Cummingtonite	Sil.	110 at 55°	Z∧*c*=15°±. 2V=90°±. Yellow: X<Z	243
	1.63	.09±		*Stilpnomelane*	Sil.	001⊥X±	2V=Sm. Green or brown: X<Z	435
	1.63	.02±		**Tourmaline (Mg)**	Sil.	X=*c*	Colorless or brown: X<Z Insol.	301
	1.64	.02±		**HORNBLENDE**	Sil.	110 at 56°	Y=*b*. Z∧*c*=20°±. 2V=80°±. X=yellow, Z=green	247
	.64	.03±		**Tourmaline (Fe)**	Sil.	X=c	Brown, green, blue: X<Z	301
1.64		Weak		**Melilite**	Sil.	X or Z=*c*	Abnor. int. colors	208
1.644		1.654	1.642	Mullite	Sil.	010⊥Y. Z=*c*	2V=50°±. Pink±: X<Z	201
	1.646	1.649	1.630	*Gastaldite*	Sil.	110 at 56°	Z∧*c*=6°±. 2V=43°±	259
1.648		1.674	1.643	*Reddingite*	Phos.	010⊥Y. Z=*c*	2V=41°. Brown: X<Z	124
	1.65	1.65	1.62	*Friedelite*	Sil.	0001⊥X	2V=0°±. Pink±	408
	1.65	1.66	1.64	**Allanite**	Sil.	Y=*b*	2V=Lg. Green: X<Z	316
	1.65	Very weak		**Apatite (Cl)**	Phos.	X=*c*	Colorless or X>Z	128
	1.65	Very weak		Daphnite	Sil.	001⊥X±	2V=0°±. Green: X<Z	285
	1.65	.01±		Thuringite	Sil.	001⊥X±	2V=0°±. Green: X<Z	285
	1.65	1.658	1.629	*Eosphorite*	Phos.	100⊥Y	2V=40°. Pleo. X>Z	156
1.651		1.670	1.635	**Forsterite**	Sil.	010⊥X	2V=85°. Gel. HCl	188
	1.652	1.675	1.612	*Liroconite*	Phos.	Z∧*c*=−25°	X=*b*. 2V=67°. Blue	157
1.653		1.675	1.653	*Plumbogummite*	Phos.	Gumlike	2V=0°. Yellow: X<Z	153
1.653		1.680	1.644	*Messelite*	Phos.	One	2V=Mod. G.=3	128
1.653		1.658	1.650	**ENSTATITE**	Sil.	110 at 88°	X=*a*; Z=*c*. 2V=31°–90°	217
	1.653	1.670	1.625	Datolite	Sil.	Z∧*c*=4°; Y=*b*	2V=74°. Gel. HCl	424
1.654		1.670	1.654	Phenakite	Sil.	11$\bar{2}$0; Z=*c*	G.=3.0. Insol.	185
1.654		1.703	1.654	*Rhabdophanite*	Phos.	Z ∥ fib.	2V=0°. Sol. HCl	139

1.654	1.660	1.651	**Clinoenstatite**	Sil.	110 at 88°	Y=*b*. Z∧*c*=22°. 2V=54°	220
1.654	1.689	1.62	*Cabrerite*	Phos.	010⊥X	Z∧*c*=33°. 2V=90°±	127
1.654	1.660	1.647	*Hureaulite*	Phos.	100; X=*b*	Z∧*c*=+75°. 2V=74° Yellow: X<Z	124
1.654	.015±		Jadeite	Sil.	110 at 87°	Y=*b*. Z∧*c*=35°. 2V=70°	235
1.655	1.655	1.650	*Wilkeite*	Sil.	X=*c*	Hex. G.=3.23	440
1.655	1.655	1.63	**Tourmaline (Mg)**	Sil.	X=*c*	Colorless or brown: X<Z. Insol.	301
1.655	1.671	1.651	*Euclase*	Sil.	010⊥Y	Z∧*c*=+41°. 2V=50°	432
1.655	1.662	1.655	*Uranochalcite*	Sul.	Z ∥ fib.	2V=Sm. Green: X<Z	117
1.656	1.660	1.652	*Palaite*	Phos.	Mono.	2V=Lg. G.=3.2	124
1.656	1.683	1.651	*Reddingite*	Phos.	010⊥Y	Z=*c*. 2V=41°	124
1.656	02±		*Gastaldite*	Sil.	110 at 56°	Z∧*c*=6°±. 2V=43°±. G.=3.0–3.1	259
1.656	1.714	1.649	*Natrochalcite*	Sul.	001; Y=*b*	Z∧*c*=12°. 2V=37°. Gr.	112
1.657	1.658	1.646	*Seybertite*	Sil.	001⊥X±	2V=Sm. Yellow: X<Z	286
1.657	1.684	1.640	*Leucosphenite*	Sil.	010⊥Z	Y∧*c*=3°. 2V=77°	418
1.658	1.695	1.640	*Veszelyite*	Phos.	Tric.?	2V=71°. Blue	138
1.658	1.687	1.622	*Annabergite*	Phos.	010⊥X	Z∧*c*=36°. 2V=84°	127
1.658	1.658	1.486	**CALCITE**	Carb.	$10\bar{1}1$; X=*c*	Efferv. HCl. G.=2.72	71
1.658	1.677	1.657	**Sillimanite**	Sil.	010⊥Y; Z=*c*	2V=30°. Colorless or X<Z	200
1.66±	.02±		**Pargasite**	Sil.	110 at 56°	Y=*b*. Z∧*c*=25°. 2V=70°. Colorless or X<Z	248
1.66±	.015±		Jadeite	Sil.	110 at 87°	Z∧*c*=35°±. 2V=75°±. G.=3.4±	235
1.66	1.670	1.655	*Salmonsite*	Phos.	Two. Z ∥ fib.	2V=Lg. Yellow: X<Z	156
1.660	1.672	1.650	*Triplite*	Phos.	100. Z∧*a*=42°	2V=Lg. Pink: X>Z	134
1.660	1.715	1.645	*Planchéite*	Sil.	Z ∥ fib.	2V=Mod. Blue: X<Z	411
1.66	Weak		*Fermorite*	Phos.	X=*c*	G.=3.5. Sol. HCl	130
1.66	1.69	1.63	*Stewartite*	Phos.	010	2V=Lg. Yellow: X<Z	128
1.660	1.675	1.640	*Tilasite*	Phos.	Z∧*c*=−30°	X=*b*. 2V=82°	134
1.660	1.661	1.649	*Xanthophyllite*	Sil.	001⊥X±	2V=Sm. X=br., Z=gr.	286
1.66	02±		**Pigeonite**	Sil.	110 at 87°	Z∧*c*=35°±. 2V=Sm. Tinted±	222
1.66	Weak		*Crossite*	Sil.	110 at 56°	X∧*c*=70°. 2V=Sm. Blue: X<Z	259
1.661	1.688	1.645	*Leucosphenite*	Sil.	010⊥Z	Y∧*c*=3°. 2V=77°	418

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g or N_g-N_p	N_p	Mineral	Chem.	Cleavage Opt. Orient.	Other Characters	Page
1.59		1.597	1.584	**Anthophyllite**	Sil.	110 at 56°	Y=*b*. Z=*c*. 2V=85°±	240
	1.59	1 59	1.555	**BIOTITE**	Sil.	001⊥X. Y=*b*	2V=0°. Br. or gr.: X<Z	272
1.62		1.63	1.61	Cummingtonite	Sil.	110 at 55°	Z∧c=15°±. 2V=90°±. Yellow: X<Z	243
	1.63	.09±		*Stilpnomelane*	Sil.	001⊥X±	2V=Sm Green or brown: X<Z	435
	1.64	.02±		**HORNBLENDE**	Sil.	110 at 56°	Y=*b*. Z∧*c*=20°±. 2V=80°± X=yellow. Z=green	247
	1.64	.03±		**Tourmaline (Fe)**	Sil.	X=*c*	Brown, green, blue: X<Z	301
1.64		Weak		**Melilite**	Sil.	X or Z=*c*	Abnor. int. colors	208
1.64		1.654	1.642	Mullite	Sil.	010⊥Y. Z=*c*	2V=50°±. Pink±: X<Z	201
	1.65	1.65	1.62	*Friedelite*	Sil.	0001⊥X	2V=0°±. Pink±	408
	1.65	1.66	1.64	**Allanite**	Sil.	Y=*b*	2V=Lg. Green: X<Z	316
	1.65	Very weak		**Apatite (Cl)**	Phos.	X=*c*	Colorless or X>Z	128
	1.65	Very weak		Daphnite	Sil.	001⊥X±	2V=0°±. Green: X<Z	285
	1.65	.01±		Thuringite	Sil.	001⊥X±	2V=0°±. Green: X<Z	285
	1.65	1.658	1.629	*Eosphorite*	Phos.	100⊥Y	2V=40°. Pleo.: X>Z	156
1.651		1.670	1.635	**Forsterite**	Sil.	010⊥X	2V=85°±. Gel. HCl	188
1.653		1.658	1.650	**ENSTATITE**	Sil.	110 at 88°	X=*a*. Z=*c*. 2V=31°–90°	217
1.654		1.660	1.651	**Clinoenstatite**	Sil.	110 at 88°	Y=*b*. Z∧*c*=22°. 2V=54°	220
	1.658	1.658	1.486	**CALCITE**	Carb.	10$\bar{1}$1. X=*c*	Efferv. HCl. G.=2.72	71
1.658		1.677	1.657	**Sillimanite**	Sil.	010⊥Y. Z=*c*	2V=30°. Colorless or X<Z	200
	1.66	.02±		**Pigeonite**	Sil.	110 at 87°	Z∧c=35°±. 2V=Sm. Tinted±	222
	1.66	Weak		*Crossite*	Sil.	110 at 56°	X∧c=70°±. 2V=Sm. Blue: X<Z	259
1.662		1.671	1.658	*Dickinsonite*	Phos.	001⊥Y±	X=*b*. 2V=Mod. Green: X>Z	122
1.662		1.727	1.629	*Lindackerite*	Sul.	010⊥Y	X∧*c*=26°. 2V=73.° Gr.	121
1.662		?	1.645	*Soddite*	Ox.	Y=*b*. Z=*c*	2V=? Yellow	61
1.662		1.699	1.626	Erythrite	Arsen.	010⊥X	Z∧c=+32° 2V=90°± Pink: X<Z	127
	1.662	1.668	1.651	Monticellite	Sil.	X=*b*. Y=*a*	2V=75°. Gel. HCl	187
1.663		?	1.652	Clinohumite [1]	Sil.	001; Z=*b*	2V=76°. Yellow: X<Y	197
	1.664	1.664	1.629	*Friedelite*	Sil.	0001⊥X	Also biax. Pink: X<Z	408

1.664	1.666 | 1.516	Strontianite	Carb.	110 at 63°	X=*c*. Z=*a*. 2V=11°	81
1.665	Weak	**Melilite**	Sil.	X or Z=*c*	Abn. int. colors	208
1.665	1.669 | 1.642	*Eosphorite*	Phos.	100⊥Y	X=*b* 2V=40°. Pink: X<Z	156
1.665	.035	**Forsterite**	Sil.	010⊥X	2V=85°±. Gel. HCl	188
1.665	1.676 | 1.660	Spodumene	Sil.	110 at 87°	Z∧*c*=+25°±. 2V=60°±. Green or lilac: X>Z	236
1.665	.035+	**CHRYSOL.(Olivine)**	Sil.	010⊥X; 100⊥Z	2V=90°±. Gel. HCl	189
1.666	1.673 | 1.661	*Johnstrupite*	Sil.	100⊥Z±	2V=70°. Lam. twin.	423
1.666	1.669 | 1.643	*Uranophane*	Sil.	One⊥X	Z ∥ fib. 2V=40°. Yellow: X<Z. Abn. int. colors	441
1.666	1.673 | 1.663	Lithiophilite	Phos.	001⊥Y; 010⊥Z	2V=60°±. Pink: X>Z	149
1.667	.001±	**Apatite** (Cl)	Phos.	X=*c*	Colorless or X>Z	128
1.667	1.673 | 1.662	Boracite	Bor.	111	2V=83°. Comp. twin.	94
1.668	1.681 | 1.665	*Rinkite*	Sil.	100. X=*b*	Y∧*c*=−8°. 2V=43°. Yellow: X<Z	423
1.667	1.667 | 1.490	*Plumbocalcite*	Carb.	1011	X=*c*	72
1.668	1.702 | 1.635	*Symplesite*	Arsen.	010⊥X	Z∧*c*=+32°. 2V=87°. Green: X>Z	126
1.669	1.689 | 1.650	*Ludlamite*	Phos.	001. Y=*b*	Z∧*c*=−67°. 2V=82°. Green	137
1.669	1.669 | 1.658	*Gehlenite*	Sil.	X=*c*	G.=3. Gel. HCl	209
1.67±	1.682 | 1.661	Mullite	Sil.	010⊥Y. Z=*c*	2V=50°. Pink±: X<Z	201
1.67	.01±	**Clinoenstatite**	Sil.	110 at 87°	Z∧*c*=25°±. 2V=50°±. G.=3.19	220
1.67	1.684 | 1.661	**Sillimanite**	Sil.	010⊥Y; Z=*c*	2V=30°. Colorless or X<Z	200
1.67	Weak	*Crossite*	Sil.	110 at 56°	X∧*c*=70°±. 2V=Sm. Blue: X<Z	259
1.67	.014	*Lotrite*	Sil.	One; Y=*b*?	2V=18°±. Green in mass	433
1.670	1.689 | 1.670	*Hinsdalite*	Sul.	0001⊥Z	Also biax. G.=4.65	119
1.670	.01	*Clinohedrite*	Sil.	010⊥Z	Y∧*c*=−28°. 2V=Lg.	413
1.670	1.670 | 1.582	*Ekmannite*	Sil.	001⊥X±	G.=2.79. Green: X<Z	281
1.67±	1.67 | 1.65	*Strigovite*	Sil.	001⊥X±	2V=0°±. Green: X<Z	437
1.670	1 670 | 1.657	*Justite*	Sil.	X=*c*	Tet. In slags	209
1.671	1.694 | 1.664	**DIOPSIDE**	Sil.	110 at 87°	Z∧*c*=39°. 2V=60°. Insol.	224
1.671	1.691 | 1.662	*Manganandalusite*	Sil.	110 at 89°	X=*a*. Z=*c*. 2V=71°. X=yellow, Y=green	202
1.671	? | ?	*Uranotile*	Sil.	100⊥X	2V=? Yellow	441
1.671	1.672 | 1.526	*Alstonite*	Carb.	010⊥Y?	2V=7°	79

[1] E. S. Larsen: *Am. Mineral.*, XIII, 1928, p. 354, gives N_m as low as 1.638 for clinohumite.

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g	N_p (or $N_g - N_p$)	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.59		1.597	1.584	**Anthophyllite**	Sil.	110 at 56°	Y=*b*. Z=*c*. 2V=85°±	240
	1.59	1.59	1.555	**BIOTITE**	Sil.	001⊥X.	Y=*b*. 2V=0°. Brown or green: X<Z	272
1.62		1.63	1.61	Cummingtonite	Sil.	110 at 55°	Z∧*c*=15°±. 2V=90°±. Yellow: X<Z	243
	1.63	.09±		*Stilpnomelane*	Sil.	001⊥X±	2V=Sm. Green or brown: X<Z	435
	1.64	.02±		**HORNBLENDE**	Sil.	110 at 56°	Y=*b*. Z∧*c*=20°±. 2V=80°±. X=yellow, Z=green	247
	1.64	.03±		**Tourmaline (Fe)**	Sil.	X=*c*	Brown, green, blue: X<Z	301
	1.65	1.66	1.64	**Allanite**	Sil.	Y=*b*	2V=Lg. Green: X<Z	316
	1.65	Very weak		Daphnite	Sil.	001⊥X±	2V=0°±. Green: X<Z	285
	1.65	.01±		Thuringite	Sil.	001⊥X±	2V=0°±. Green: X<Z	285
1.653		1.658	1.650	**ENSTATITE**	Sil.	110 at 88°	X=*a*. Z=*c*. 2V=31°–90°	217
	1.658	1.658	1.486	**CALCITE**	Carb.	10$\bar{1}$1. X=*c*	Efferv. HCl. G.=2.72	71
	1.66	.02±		**Pigeonite**	Sil.	110 at 87°	Z∧*c*=35°±. 2V=Sm. Tinted±	222
1.663		?	1.652	Clinohumite	Sil.	001. Z=*b*	2V=76. Yellow: X<Y	197
	1.665	.035+		**CHRYSOL.(Olivine)**	Sil.	010⊥X; 100⊥Z	2V=90°±. Gel. HCl	189
1.666		1.673	1.663	Lithiophilite	Phos.	001⊥Y; 010⊥Z	2V=60°±. Pink: X>Z	149
1.669		1.689	1.650	*Ludlamite*	Phos.	001. Y=*b*	Z∧*c*=−67°. 2V=82°. Green	137
1.67		1.694	1.664	**DIOPSIDE**	Sil.	110 at 87°	Z∧*c*=39°. 2V=60°. Insol.	224
1.672		1.676	1.672	*Fillowite*	Phos.	001	2V=Sm. Sol. HCl	123
1.672		1.771	1.672	*Parisite*	Carb.	0001⊥Z	Colorless or yellow: X<Z. Efferv. HCl	85
	1.672	1.672	1.661	*Hardystonite*	Sil.	001⊥X	G.=3.4. Gel. HCl	209
1.673		1.682	1.665	*Triplite*	Phos.	100; Y=*b*	Z∧*a*=42°. 2V=Lg. Pink: X>Z	134
1.673		1.698	1.664	Clinohumite	Sil.	001; Z=*b*	2V=70°. Yellow: X>Y	197
	1.673	1.685	1.634	*Durangite*	Arsen.	110 at 70°	X∧*c*=−25°. Z=*b*. 2V=57°. Yellow: X>Z.	151
	1.673	1.674	1.661	*Kornerupine*	Sil.	110 at 81°	X=*c*; Y=*a*. 2V=20°. Colorless or X=yellow, Z=green	421
1.674		1.684	1.665	Lawsonite	Sil.	010⊥Y; 001⊥Z	2V=84°. Blue±: X>Z	430
1.674±		1.688	1.666	*Jadeite-diopside*	Sil.	110 at 87°	Y=*b*. Z∧*c*=45°. 2V=75°	235

1.674	1.684	1.671	*Natrophilite*	Phos.	001 ⊥ Y; 010 ⊥ Z	2V = 72°. Yellow	150
1.674	1.699	1.663	*Spodiosite*	Phos.	010	2V = 69°. Sol. HCl	135
1.674	1.676	1.662	*Bustamite*	Sil.	010, 110, 1$\bar{1}$0	X ⊥ 010 ±. 2V = 44°	406
1.674	1.679	1.640	*Spurrite*	Sil.	001 ⊥ Y ±	2V = 40°. Lam. twin.	442
1.675	1.684	1.665	**HORNBLENDE**	Sil.	110 at 56°	Y = b. Z∧c = 20° ±. 2V = 80° ±. X = yellow, Z = green	247
1.675	1.697	1.653	*Ludlamite*	Phos.	001. Y = b	Z∧c = −67°. 2V = 82° ±. Green	137
1.675	1.689	1.661	*Liskeardite*	Arsen.	010 ⊥ X	2V = Lg. G. = 3. Insol.	142
1.675	1.675	1.59	*Chloromagnesite*	Hal.	0001 Lam.	Deliques.	32
1.675	1.675	1.636	*Pyrosmalite*	Sil.	0001 ⊥ X	Green ±; X < Z	408
1.676	1.677	1.529	Witherite	Carb.	010 ⊥ Y. X = c	2V = 16°. Ps. Hex. twin.	81
1.677	1.677	1.665	*Kornerupine*	Sil.	110 at 81°	X = c. Y = a. 2V = 20°. Colorless or X = yellow, Z = green	421
1.678	1.702	1.669	*Titanclinohumite*	Sil.	X∧a = −8°	Z = b. 2E = 120°. Gel. HCl	198
1.678	1.684	1.643	*Childrenite*	Phos.	X = b; Y = a	2V = 45°. G. = 3.2. Sol. HCl	155
1.679	1.679	1.502	**DOLOMITE (Mg)**	Carb.	10$\bar{1}$1. X = c	G. = 2.87. Efferv. HCl	73
1.68	.01 ±		**ENSTATITE**	Sil.	110 at 88°	X = a; Z = c. 2V = 90° ±	217
1.68	1.70	1.66	Cummingtonite	Sil.	110 at 55°	Y = b. Z∧c = 15°. 2V = 80° ±	243
1.68	Very weak		Daphnite	Sil.	001 ⊥ X ±	2V = Sm. Green: X < Z	285
1.68	.01 ±		Thuringite	Sil.	001 ⊥ X ±	2V = Sm. Green: X < Z	285
1.68	1.683	1.678	*Harstigite*	Sil.	X = c; Y = b	2V = 52°. G. = 3.05	432
1.680	1.685	1.680	*Florencite*	Phos.	0001 ⊥ Z	Yellow ±. G. = 3.59	142
1.68?	Strong		*Erythrosiderite*	Hal.	X = a. Y = c	Yellow. Deliques.	35
1.680	1.720	1.620	*Zippeite*	Sul.	010 ⊥ X	Z∧c = 35° ±. 2V = Lg. Yellow: X < Z	110
1.68	Strong		**OXYHORNBLENDE**	Sil.	110 at 56°	Z∧c = Sm. 2V = 80° ±. Brown: X < Z	252
1.68	.012 ±		**HYPERSTHENE**	Sil.	110 at 88°	X = a; Z = c. 2V = 80° ±. X = reddish, Z = greenish	219
1.68	1.70	1.66	Grunerite	Sil.	110 at 56°	Z∧c = 15° ±. 2V = 80° ±. Brown: X < Z	242
1.681	1.683	1.667	*Cenosite*	Sil.	One	2V = Mod. Yellow	440
1.681	1.685	1.530	**Aragonite**	Carb.	010, 110	X = c; Z = b. 2V = 18°. Efferv. HCl	79
1.682 ±	1.684	1.671	*Prismatine*	Sil.	110 at 81°	X = c. 2V = Sm. Yellow: X > Z	421
1.683	1.717	1.662	*Koettigite*	Arsen.	010 ⊥ X	Z∧c = 37°. 2V = 77°. Red	127
1.683 ±	1.70	1.61	*Roscoelite*	Sil.	001 ⊥ X ±	2V = Sm. Olive-green: X < Z	270
1.684	1.686	1.525	*Barytocalcite*	Carb.	110 at 73°	Z = b. X∧c = 64°. 2V = 15°.	82

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g or N_g-N_p	N_p	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.59		1.597	1.584	**Anthophyllite**	Sil.	110 at 56°	Y=*b*. Z=*c*. 2V=85°±	240
	1.59	1.59	1.555	**BIOTITE**	Sil.	001⊥X	Y=*b*. 2V=0. Brown or green: X<Z	272
	1.63	.09±		*Stilpnomelane*	Sil.	001⊥X±	2V=Sm. Green or brown: X<Z	435
	1.64	.03±		**Tourmaline (Fe)**	Sil.	X=*c*	Brown, green, blue: X<Z	301
	1.65	1.66	1.64	**Allanite**	Sil.	Y=*b*	2V=Lg. Green: X<Z	316
	1.658	1.658	1.486	**CALCITE**	Carb.	$10\bar{1}1$. X=*c*	Efferv. HCl. G.=2.72	71
	1.66	.02±		**Pigeonite**	Sil.	110 at 87°	Z∧*c*=35°±. 2V=Sm. Tinted±	222
1.665		.035+		**CHRYSOL. (Olivine)**	Sil.	010⊥X; 100⊥Z	2V=90°±. Gel. HCl	189
1.666		1.673	1.663	Lithiophilite	Phos.	001⊥Y; 010⊥Z	2V=60°±. Pink: X>Z	149
1.671		1.694	1.664	**DIOPSIDE**	Sil.	110 at 87°	Y=*b*. Z∧*c*=39°. 2V=60°	224
	1.679	1.679	1.502	**DOLOMITE (Mg)**	Carb.	$10\bar{1}1$. X=*c*	Efferv. HCl. G.=2.87	73
	1.680	1.720	1.620	*Zippeite*	Sul.	010⊥X	Z∧*c*=35°±. 2V=Lg. Yellow: X<Z	110
	1.68	Strong		**OXYHORNBLENDE**	Sil.	110 at 56°	Z∧*c*=Sm. 2V=80°±. Brown: X<Z	252
	1.68	.012±		**HYPERSTHENE**	Sil.	110 at 88°	X=*a*. Z=*c*. 2V=80°±. X=reddish, Z=greenish	219
	1.68	1.70	1.66	Grunerite	Sil.	110 at 56°	Z∧*c*=15°±. 2V=80°±. Brown: X<Z	242
	1.684	1.686	1.659	Dumortierite	Sil.	100⊥Z	2V=30°±. Blue, etc. X>Z	422
1.685		.01±		Lithiophilite	Phos.	001⊥Y; 010⊥Z	2V=40°±. Pink: X>Z	149
	1.685	1.689	1.679	**Axinite**	Sil.	$\bar{1}12$, 010	2V=73°±. X, Z=yellow, Y=violet	425
1.685		1.695	1.681	*Barylite*	Sil.	001⊥Z	2V=65°. G.=4	401
1.685		.01±		Triphylite	Phos.	001⊥Y or X	2V=Var. Sol. HCl	149
1 686		1.698	1.681	*Titano-elpidite*	Sil.	110	X=*b*. Y=*c*. 2V=Mod.	400
	1.686	1.698	1.67	*Trichalcite*	Arsen.	Y ‖ elong.	2V=Lg. Blue-green	124
1.687		1.711	1.682	*Rosenbuschite*	Sil.	001	X=*b*. Z∧*c*=−13°. 2V=60°. Yellow: X<Z	419
1.687		1.709	1.680	Aegirinaugite	Sil.	110 at 87°	Z∧*c*=65°±. 2V=65°±. X=green, Z=yellow	232
	1.687±	Weak		**Riebeckite**	Sil.	110 at 56°	X∧*c*=Sm. 2V=Lg. X=blue, Z=green	257
	1.687	1 690	1.658	*Shroeckingerite*	Carb.	010⊥X	2V=40°. Yellow: X<Z	86

1.69	1.69	1.60±	*Stilpnomelane*	Sil.	001⊥X±	2V = Sm. Brown to green: X<Z	435
1.69	1.70	1.68	**Anthophyllite**	Sil.	110 at 54°	Y = *b*; Z = *c*. 2V = Lg. Insol.	240
1.69	1.69	1.52±	*Manganocalcite*	Carb.	10$\bar{1}$1. X = *c*	Efferv. HCl	72
1.69	1.69	1.66	**Tourmaline (Fe)**	Sil.	X = *c*	X<Z. Insol.	301
1.69±	1.701	1.680	Barkevikite	Sil.	110 at 56°	Z∧*c* = 12°±. 2V = 40°±. Brown: X<Z	254
1.69	1.710	1.682	*Jeffersonite*	Sil.	110 at 87°	Z∧*c* = 54°. 2V = Lg. Brown	228
1.690	1.693	1.675	*Sincosite*	Phos.	001⊥X	Also biax. Green: X<Z	147
1.690	1.697	1.682	*Chlorophoenicite*	Arsen.	100⊥Opt. Ax.	2V = 83°. Green-red	134
1.69	1.71	1.685	**AUGITE**	Sil.	110 at 87°	Z∧*c* = 45°±. 2V = 60°±. Tinted±	228
1.69	.005±		Arfvedsonite	Sil.	110 at 56°	X∧*c* = Sm. Z = *b*. 2V = Lg. X = blue-green, Z = gray	257
1.691	1.692	1.670	Dumortierite	Sil.	100⊥Z	2V = 30°. Blue, etc. X>Z	422
1.691	Very weak		*Fuggerite*	Sil.	001⊥X	Tet. Abn. int. colors	210
1.693	.005		*Pharmacosiderite*	Phos.	Y = *b*?	2V = Sm. Comp. twin.	143
1.694±	1.723	1.694	Willemite	Sil.	0001⊥Z	G. = 4±. Gel. HCl	186
1.694	1.694	1.641	*Spangolite*	Sul.	0001⊥X	X = bluish green, Z = gr.	119
..695	1.697	1.693	**Riebeckite**	Sil.	110 at 56°	X∧*c* = Sm. 2V = Lg. X = blue, Z = green	257
1.695±	.012		*Guarinite*	Sil.	110 at 90°±	2V = 90°±. Yellow, pleo.	406
1.695	1.698	1.684	*Kempite*	Hal.	X = *c*; Y = *b*	2V = Mod. Green	39
1.696	1.703	1.691	*Barylite*	Sil.	001⊥Z	2V = 81°. G. = 4	401
1.696	1.702	1.696	**Zoisite**	Sil.	010⊥Y or X	2V = Sm. Abn. int. colors	311
1.698	1.733	1.695	*Euchroite*	Phos.	X = *b*; Y = *a*	2V = 29°. Green	136
1.698	1.706	1.660	*Schroeckingerite*	Carb.	010⊥X	2V = 57°. Yellow: X<Z	86
1.70	1.70	1.62	**BIOTITE**	Sil.	001⊥X±	2V = 0°±. Brown: X<Z	272
1.70	.02		**Pigeonite**	Sil.	110 at 87°	Z∧*c* = 35°±. 2V = Sm. Tinted±	222
1.70	1.72	1.695	**DIOPSIDE**	Sil.	110 at 87°	Z∧*c* = 42°±. 2V = 60°±. Insol.	224
1.70	1.70	1.52	**DOLOMITE (Mg)**	Carb.	10$\bar{1}$1. X = *c*	Efferv. HCl	73
1.70	1.72	1.68	**CHRYSOL.(Olivine)**	Sil.	010⊥X; 100⊥Z	2V = 85°±. Gel. HCl	189
1.70	1.720	1.630	*Zippeite*	Sul.	010⊥X	Z∧*c* = 35°±. 2V = Lg. Yellow: X<Z	110
1.700	1.736	1.690	*Neptunite*	Sil.	110 at 80°	Z∧*c* = 20°±. 2V = 49°. Red: X<Z	418

* A. F. Buddington: *Amer. Jour. Sci.* cciii, 1922, p. 74.

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g or N_g-N_p	N_p	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
	1.65	1.66	1.64	**Allanite**	Sil.	Y=*b*	2V=Lg. Green: X<Z	316
	1.68	Strong		**OXYHORNBLENDE**	Sil.	110 at 56°	Z∧*c*=Sm. 2V=80°±. Brown: X<Z	252
	1.68	.012±		**HYPERSTHENE**	Sil.	110 at 88°	X=*a*, Z=*c*. 2V=90°±. X=reddish, Z=greenish	219
	1.68	1.70	1.66	Grunerite	Sil.	110 at 56°	Z∧*c*=15°±. 2V=80°±. Brown: X<Z	242
1.685		.01±		Triphylite	Phos.	001⊥Y or X	2V=Var. Sol. HCl	149
1.687		1.709	1.680	Aegirinaugite	Sil.	110 at 87°	Z∧*c*=65°±. 2V=65°±. X=green, Z=yellow	232
1.69		1.71	1.685	**AUGITE**	Sil.	110 at 87°	Z∧*c*=45°±. 2V=60°. Tinted±	228
1.69		.005±		Arfvedsonite	Sil.	110 at 56°	X∧*c*=Sm. Z=*b*. 2V=Lg. X=blue-green, Z=gray	257
1.696		1.702	1.696	**Zoisite**	Sil.	010⊥Y or X	2V=Sm. Abn. int. colors	311
1.7±		.012		*Hainite*	Sil.	010⊥Z±	2V=Lg. Yellow: X<Z	406
1.700		1.708	1.698	*Pumpellyite*	Sil.	010⊥X	Y=*b*. Green: X<Y	432
	1.700	1.735	1.625	*Ancylite*	Carb.	X=*a*; Z=*c*	2V=66°. Green, etc.	87
	1.70+	1.712	1.639	*Sussexite*	Bor.	X ∥ fib.	2V=Sm. G.=3.1	91
	1.70	1.700	1.509	Magnesite	Carb.	10$\bar{1}$1. X=*c*	Efferv. HCl. G.=2.96	75
	1.70	1.72	1.695	**Salite**	Sil.	110 at 87°	Z∧*c*=42°±. 2V=60°±. Insol.	227
	1.70	1.70	1.52	Ankerite	Carb.	10$\bar{1}$1. X=*c*	Efferv. HCl. G.=3±	73
	1.70	1.72	1.68	Hyalosiderite	Sil.	010⊥X; 100⊥Z	2V=80°±. Gel. HCl	189
	1.701	1.704	1.693	*Tinzenite*	Sil.	100⊥X±	2V=63°. Green: X>Z	428
1.702		1.706	1.700	**Zoisite**	Sil.	010⊥Y or X	2V=Sm. Colorless or X=pink, Z=yellow	311
1.703		1.733	1.678	*Astrophyllite*	Sil.	010⊥X	2V=75°. Yellow: X>Z	417
1.703		1.706	1.701	*Serendibite*	Sil.	None	2V=90°±. X=yellow, Z=blue	425
	1.704	1.704	1.679	*Schallerite*	Sil.+	One⊥X	2V=0°. G.=3.37	440
	1.705	1.705	1.701	Vesuvianite	Sil.	110 at 90°	2V=0°. Colored±	207
1.705		1.724	1.700	*Graftonite*	Phos.	X=*b*	2V=55°±. G.=3.67	122
	1.705	1.713	1.660	*Tarbuttite*	Phos.	001	2V=50°. Sol. HCl	135
	1.706	1.706	1.698	*Svabite*	Arsen.	X=*c*	2V=0°. Sol. HCl	129
	1.707	1.708	1.704	*Sapphirine*	Sil.	Z∧*c*=10°±	Y=*b*. 2V=69°. Blue: X<Z	427

1.707	1.707	1.517	*Breunnerite*	Carb.	10$\bar{1}$1. X=*c*	Efferv. HCl	75
1.708	1.745	1.708	*Strengite*	Phos.	001⊥Z	2V=Sm. Pink±: X<Z	140
1.71+	1.71	1.70	Triphylite	Phos.	001⊥X	2V=Sm. Sol. HCl	149
1.71	.025±		**AUGITE**	Sil.	110 at 87°	Z∧*c*=45°±. 2V=60°. Tinted±: X<Y	228
1.71	.01±		**Allanite?**	Sil.	?	2V=Lg. Brown: X<Z	316
1.71	1.71	1.52	Magnesite	Carb.	10$\bar{1}$1	Efferv. HCl	75
1.71	.005±		Arfvedsonite	Sil.	110 at 56°	X∧*c*=10°±. Z=*b*. 2V=Lg. Blue: X>Z	257
1.71±	.04±		Grunerite	Sil.	110 at 56°	Z∧*c*=15°±. 2V=80°±. Green to brown: X<Z	242
1.71	.01±		*Stibiconite*	Ox.	?	G.=5.2±. Insol.	68
1.711	1.718	1.708	*Merwinite*	Sil.	010⊥Z	X∧*c*=36°. 2V=67°. Gel. HCl	194
1.711	1.724	1.709	*Brandtite*	Arsen.	010⊥X	Y∧*c*=+7°. 2V=23°. Sol. HCl	125
1.712	Strong		*Palmierite*	Sul.	Hex.	G.=4.5. Sol. HNO_3	110
1.713	1.722	1.703	*Gerhardtite*	Nit.	001⊥Z; 100⊥X	2V=Lg. X=gr., Z=blue	89
1.714	1.735	1.690	*Schoepite*	Ox.	001⊥X	2V=Lg. Yellow: X<Z	60
1.715±	1.73	1.713	**Clinohypersthene**	Sil.	110 at 87°	Z∧*c*=30°±. 2V=30°±. G.=3.4±	221
1.715	Weak		**Clinozoisite**	Sil.	001. X∧*c*=Sm.	2V=Lg. Tinted±: X<Z	312
1.715	1.718	1.674	Iddingsite	Sil.	100⊥X; 001⊥Z	2V=Var. Brown: X<Z	437
1.716±	Weak		*Viluite*	Sil.	Z=*c*	G.=3.4±. Tinted±	207
1.716	1.726	1.700	*Woehlerite*	Sil.	010⊥Z	X∧*c*=−45°. 2V=75°±. Yellow: X<Z	441
1.716	1.729	1.679	*Glaucochroite*	Sil.	X=*b*; Y=*c*	2V=61°. Gel. HCl	187
1.717	1.818	1.717	*Bastnäsite*	Carb.	Z=*c*	G.=5.0. Efferv. HCl	85
1.718	1.733	1.715	*Magnesium-orthite*	Sil.	Poor	2V=50°. Brown	317
1.719	1.719	1.527	*Mesitite*	Carb.	10$\bar{1}$1. X=*c*	Efferv. HCl	75
1.72	1.735	1.71	**Salite**	Sil.	110 at 87°	Z∧*c*=45°. 2V=60°. Tinted±	227
1.72	.015±		**HYPERSTHENE**	Sil.	110 at 88°	X=*a*; Z=*c*. 2V=65°±. X=reddish, Z=greenish	219
1.720	1.725	1.715	*Trimerite*	Sil.	001⊥X±	2V=83°. Sol. HCl	401
1.720	1.720	1.691	*Phosphuranylite*	Phos.	010⊥X	2V=0°±. Yellow: X<Z	147
1.72	1.72	1.53	Mangandolomite	Carb.	10$\bar{1}$1. X=*c*	G=3.3±. Efferv. HCl	73
1.721	1.816	1.721	Xenotime	Phos.	110 at 90°	G.=4.59. Insol.	138
1.721	1.731	1.712	*Adelite*	Arsen.	Y=*b*	Z∧*c*=+39°. 2V=Lg. G.=3.75	134
1.722	1.735	1.686	*Glaucochroite*	Sil.	X=*b*. Y=*c*	2V=61°. Gel. HCl	187

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g	N_p	Mineral	Chem.	Cleavage Opt. Orient.	Other Characters	Page
	1.65	1.66	1.64	**Allanite**	Sil.	Y=*b*	2V=Lg. Green: X<Z	316
	1.68	Strong		**OXYHORNBLENDE**	Sil.	110 at 56°	Z∧*c*=Sm. 2V=80°±. Brown: X<Z	252
1.687		1.709	1.680	Aegirinaugite	Sil.	110 at 87°	Z∧*c*=65°±. 2V=65°±. X=green, Z=yellow	232
	1.70	1.70	1.52	Ankerite	Carb.	10$\bar{1}$1. X=*c*	Efferv. HCl. G.=3±	73
	1.70	1.72	1.68	Hyalosiderite	Sil.	010⊥X. 100⊥Z	2V=85°±. Gel. HCl	189
	1.705	1.705	1.701	Vesuvianite	Sil.	110 at 90°	2V=0°. Colored±	207
	1.707	1.708	1.704	*Sapphirine*	Sil.	Z∧*c*=10°±	Y=*b*. 2V=69°. Blue: X<Z	427
	1.707	1.707	1.517	*Breunnerite*	Carb.	10$\bar{1}$1. X=*c*	Efferv. HCl	75
1.708		1.745	1.708	*Strengite*	Phos.	001⊥Z	2V=Sm. Pink±: X<Z	140
	1.71	.01±		**Allanite?**	Sil.	?	2V=Lg. Brown: X<Z	316
1.71		.01±		*Stibiconite*	Ox.	?	G.=5.2. Insol.	68
1.715		Weak		**Clinozoisite**	Sil.	001. X∧*c*=Sm.	2V=Lg. Tinted±: X<Z	312
	1.715	1.718	1.674	Iddingsite	Sil.	100⊥X; 001⊥Z	2V=Var. Brown: X<Z	437
	1.719	1.719	1.527	*Mesitite*	Carb.	10$\bar{1}$1. X=*c*	Efferv. HCl	75
	1.72	1.72	1.53	Mangandolomite	Carb.	10$\bar{1}$1. X=*c*	Efferv. HCl. G.=3.3±	73
1.722		1.824	1.722	*Bastnäsite*	Carb.	Z=*c*. Hex.	G.=5.0. Efferv. HCl	85
1.722		1.750	1.702	Diaspore	Ox.	010⊥Y	2V=84°. Colorless or red±: X>Z	46
	1.722	1.729	1.717	**Kyanite**	Sil.	100⊥X±	2V=83°. H=4 to 7.5	205
1.722		1.731	1.720	Chloritoid	Sil.	001⊥Z±	2V=Mod. X=gr., Y=bl.	438
	1.723	1.723	1.681	*Pyrochroite*	Ox.	0001⊥X	Brown±: X<Z	42
1.724		1.746	1.724	*Connellite*	Sul.	Z=*c*	G.=3.38. Blue	118
1.725		1.738	1.715	*Homilite*	Sil.	Z=*b*. Y=*c*±	2V=80°. Brown: Y>Z	424
1.725		.01		*Roselite*	Arsen.	100⊥X±	Tr. 2V=Mod. Red: X>Z	127
1.725		Very weak		*Sarcopsite*	Phos.	001, 010	Mon.? G.=3.64	134
	1.725	1.738	1.692	*Phosphosiderite*	Phos.	010⊥Y	X∧*c*=4°. 2V=62°. Red±: Y>Z	142
1.726		1.746	1.713	Babingtonite	Sil.	1$\bar{1}$0, 110	2V=60°. X=gr., Y=br.	428

1.726	1.730	1.725	*Triploidite*	Phos.	100. X=*b*	2V=Mod. G.=3.7	134
1.726	1.730	1.694	*Tyrolite*	Arsen.	001⊥X	2V=36°. Green: X>Y	161
1.726	1.730	1.721	Rhodonite	Sil.	110, 1$\bar{1}$0, 001	2V=76°. G.=3.5±	403
1.727±	1.740	1.711	*Picrotephroite*	Sil.	001, 010	2V=85°. Gel. HCl	194
1.728	.05		*Adamite*	Arsen.	X=*a*. Y=*c*	2V=83°. Pink±	133
1.729	1.730	1.705	*Ganophyllite*	Sil.	001⊥X±; 010	Z=*b*. 2V=24°. Brown: X>Z	436
1.73	1.76	1.69	**OXYHORNBLENDE**	Sil.	110 at 56°	Z∧*c*=Sm. 2V=80°. Brown: X<Z	252
1.73±	.01		*Ottrelite*	Sil.	001⊥Z±	2V=Var. X=gr., Y=bl.	438
1.730	1.810	1.730	*Mixite*	Arsen.	Z=*c*	2V=Sm. Green	156
1.73	1.73	1.72	*Melanocerite*	Sil.	X=*c*	G.=4.13. Yellow	420
1.73	1.745	1.725	**Hedenbergite**	Sil.	110 at 87°	Z∧*c*=45°. 2V=60°. Green: X<Z	224
1.73	1.75	1.72	*Piedmontite*	Sil.	001. Y=*b*	2V=70°. X=yel., Z=red	315
1.731±	1.748	1.720	*Jeffersonite*	Sil.	110 at 87°	Z∧*c*=54°. 2V=Mod. G.=3.5	228
1.731	1.732	1.710	*Chalcomenite*	Sel.	Y=*b* (Li)	2V=Sm. Sol. HCl	118
1.732	.05±		*Phosphosiderite*	Phos.	010⊥Y	X∧*c*=4°. 2V=62°. Red±: Y>Z	142
1.732	1.762	1.730	*Strengite*	Phos.	001⊥Z	2V=29°. Pink: X<Z	140
1.733	1.734	1.729	*Sapphirine*	Sil.	Z∧*c*=10°±	2V=69°. Blue: X<Z	427
1.733	.04		*Pyrochroite*	Ox.	0001⊥X	Brown±: X<Z	42
1.733	1.733	1.714	*Hematolite*	Phos.	0001⊥X	Also biax. Yellow	153
1.733	1.87	1.72	*Ferrimolybdite*	Molyb.	001⊥Z	2V=28°. Yellow: X<Z	108
1.734	2.07	1.557	*Curtisite*	C,H,O	001⊥Z	Y=*b*. 2V=83°	18
1.734	1.758	1.708	*Adamite*	Arsen.	X=*a*; Y=*c*	2V=83°. Colorless or X>Z	133
1.735	.01±		**Clinozoisite**	Sil.	001; Y=*b*	2V=Lg. Tinted±. X<Z	312
1.735	1.758	1.735	*Connellite*	Sul.	Z=*c*	Blue. Sol. HCl	118
1.735	1.75	1.715	*Hodgkinsonite*	Sil.	001⊥Z±	2V=Mod. Gel. HCl	412
1.735	1.745	1.715	*Sicklerite*	Phos.	One⊥Z	2V=Lg. Yellow: X>Z	158
1.735	.03±		**PISTAC. (Epidote)**	Sil.	001; Y=*b*	2V=Lg. Yellow: X<Y	314
1.736	1.736	1.732	Vesuvianite	Sil.	X=*c*	Also biax. G.=3.4	207
1.736±	1.750	1.640	*Hydrozincite*	Carb.	100. X=*b*	2V=40°. Efferv. HCl	83
1.737	1.785	1.730	*Antlerite*	Sul.	010⊥X	2V=35°. Green: X<Z	102
1.738	1.746	1.718	*Shannonite*	Sil.	010⊥Z	2V=64°. Sol. HCl	195

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g	N_p or $N_g - N_p$	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
	1.65	1.66	1.64	**Allanite**	Sil.	Y=*b*	2V=Lg. Green: X<Z	316
1.687		1.709	1.680	Aegirinaugite	Sil.	110 at 87°	Z∧*c*=65°±. 2V=65°±. X=green, Z=yellow	232
	1.70	1.70	1.52	Ankerite	Carb.	10$\bar{1}$1. X=*c*	Efferv. HCl. G.=3±	73
	1.70	1.72	1.68	Hyalosiderite	Sil.	010⊥X; 100⊥Z	2V=85°±. Gel. HCl	189
	1.707	1.707	1.517	*Breunnerite*	Carb.	10$\bar{1}$1. X=*c*	Efferv. HCl	75
	1.71	.01±		**Allanite?**	Sil.	?	2V=Lg. Brown: X<Z	316
	1.71	.01±		*Stibiconite*	Ox.	?	G.=5.2. Insol.	68
	1.715	1.718	1.674	Iddingsite	Sil.	100⊥X; 001⊥Z	2V=Var. Brown: X<Z	437
	1.719	1.719	1.527	*Mesitite*	Carb.	10$\bar{1}$1. X=*c*	Efferv. HCl	75
	1.72	1.72	1.53	Mangandolomite	Carb.	10$\bar{1}$1. X=*c*	Efferv. HCl. G.=3.3±	73
1.722		1.731	1.720	Chloritoid	Sil.	001⊥Z±	2V=Mod. X=green, Y=blue	438
	1.726	1.730	1.721	Rhodonite	Sil.	110, 1$\bar{1}$0, 001	2V=76°. G.=3.5±	403
1.730		1.810	1.730	*Mixite*	Arsen.	Z=*c*	2V=Sm. Green	156
1.73		1.745	1.725	**Hedenbergite**	Sil.	110 at 87°	Z∧*c*=45°±. 2V=60°. Green: X<Z	224
1.73		1.75	1.72	*Piedmontite*	Sil.	001. Y=*b*	2V=70°. X=yel., Z=red	315
1.733		1.87	1.72	*Ferrimolybdite*	Molyb.	001⊥Z	2V=28°. Yellow: X<Z	108
	1.735	.03±		**PISTAC. (Epidote)**	Sil.	001. Y=*b*	2V=Lg. Yellow: X<Y	314
	1.738	1.744	1.731	*Thalenite*	Sil.	Y=*c*±; Z=*b*	2V=70°±. G.=4.3±	414
1.74		.03±		Aegirinaugite	Sil.	110 at 87°	X∧*c*=40°±. 2V=Lg. Green: X>Z	232
	1.74	1.74	1.54	Ankerite	Carb.	10$\bar{1}$1. X=*c*	G.=3.1. Efferv. HCl	73
	1.74	1.744	1.733	Rhodonite	Sil.	110, 1$\bar{1}$0, 001	2V=76°. G.=3.5	403
1.74±		1.775	1.735	*Jadeite-acmite*	Sil.	110 at 87°	X∧*c*=5°. 2V=Lg.	193
1.74±		.01		*Sismondine*	Sil.	001⊥Z±	2V=50°±. X=green, Y=blue	438
1.74		1.770	1.735	*Molengraafite*	Sil.	100⊥Y±	2V=28°. Yellow: Y<Z	244
	1.74±	Strong		*Vilatéite*	Phos.	Z=*c*?	2V=Mod. Pink: X<Z	140
	1.740	1.744	1.655	*Aurichalcite*	Carb.	100⊥Y±	2V=Sm. Green: X<Z	84

1.74+	Strong		*Melanovanadite*	Sul.	010⊥X	2V=Sm. Brown: X<Z	102
1.74	1.74	1.54	Ferrodolomite	Carb.	$10\bar{1}1$. X=c	Efferv. HCl	73
1.741	1.746	1.736	**Staurolite**	Sil.	010⊥X	2V=88°. Yellow: X<Z	202
1.742	1.765	1.738	Scorodite	Arsen.	X=b; Y=a	2V=Mod. Green, pleo.	139
1.745	1.757	1.739	**Hedenbergite**	Sil.	110 at 87°	Z∧c=48°. 2V=60°. Green: X<Z	224
1.745	1.830	1.745	*Mixite*	Arsen.	Z=c	2V=Sm. Green	156
1.745	1.789	1.702	*Libethenite*	Phos.	X=b; Y=c	2V=83°. Green: Y>Z	132
1.748±	1.755	1.745	*Chrysoberyl*	Ox.	Y=b; Z=c	2V=60°±. G.=3.64	65
1.748	1.748	1.645	*Freirinite*	Phos.	001⊥X	2V=0°. Blue: X<Z	151
1.75	1.77	1.72	Hyalosiderite	Sil.	010⊥X	2V=80°. Gel. HCl	189
1.75	1.75	1.55	Mangandolomite	Carb.	$10\bar{1}1$. X=c	Efferv. HCl. G.=3.3	73
1.75	1.75	1.55	*Breunnerite*	Carb.	$10\bar{1}1$. X=c	Efferv. HCl	75
1.750	.030±		*Laavenite*	Sil.	100	X∧c=20°. 2V=80°. Yellow±: X<Z	420
1.75	1.788	1.743	*Lorenzenite*	Sil.	120. Z=b	2V=39°. Insol.	400
1.75	1.80	1.72	*Rutherfordite*	Carb.	?	G.=4.8. Yellow±	86
1.75	1.87±	1.57	*Hoelite*	H, C	X=c; Y=a	2V=Sm. G.=1.43	18
1.754	1.762	1.747	**Staurolite**	Sil.	010⊥X	2V=Lg. Golden: X<Z	202
1.754	1.764	1.743	*Caracolite*	Sul.	None	2V=Lg. Ps. Hex. twin.	120
1.755±	.01±		*Pyroxmangite*	Sil.	110 at 88°	Z∧c=45°. 2V=30°. Yellowish	406
1.755	1.82	1.755	*Vegasite*	Sul.	$10\bar{1}1$. Z=c	Yellow: X<Z	116
1.757	1.804	1.757	*Benitoite*	Sil.	Z=c	Blue, etc. X<Z	212
1.758	1.838	1.730	Azurite	Carb.	100⊥Y±	2V=68°. Blue: X<Z	82
1.76	.02		**Allanite?**	Sil.	?	Brown: X<Z	316
1.76	1.81	?	*Glockerite*	Sul.	?	Brown, green	108
1.76	1.76	1.63	*Chalcodite*	Sil.	001⊥X±	2V=Sm. X=yel, Z=br.	435
1.76	Strong		*Cappelenite*	Sil.	X=c	Brown. Sol. HCl	420
1.760	1.760	1.577	*Cordylite*	Carb.	0001⊥X	Colorless or yellow: X>Z	86
1.760	1.798	1.708	*Langite*	Sul.	001⊥X	2V=81°. Blue-gr.: X<Z	102
1.762	1.805	1.719	*Dihydrite*	Phos.	X∧c=+22°	2V=90°±. Green: X>Z	135
1.763	?	1.762	*Dewindtite*	Phos.	100⊥X	2V=Lg. Yellow	148
1.763	1.768	1.724	Iddingsite	Sil.	100⊥X; 001⊥Z	2V=40°±. Brown: X<Z	437

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g	N_p	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
	1.65	1.66	1.64	**Allanite**	Sil.	Y=*b*	2V=Lg. Green: X<Z	316
1.71		.01± (or N_g-N_p)		*Stibiconite*	Ox.	?	G.=5.2. Insol.	68
	1.719	1.719	1.527	*Mesitite*	Carb.	10$\bar{1}$1. X=*c*	Efferv. HCl	75
1.722		1.731	1.720	Chloritoid	Sil.	001⊥Z±	2V=Mod. X=green, Y=blue	438
1.73		1.75	1.72	*Piedmontite*	Sil.	001. Y=*b*	2V=70. X=yel., Z=red	315
1.733		1.87	1.72	*Ferrimolybdite*	Molyb.	001⊥Z	2V=28°. Yellow: X<Z	108
	1.735	.03± (or N_g-N_p)		**PISTAC. (Epidote)**	Sil.	001. Y=*b*	2V=Lg. Yellow: X<Y	314
	1.74	1.74	1.54	Ferrodolomite	Carb.	10$\bar{1}$1. X=*c*	Efferv. HCl	73
1.742		1.765	1.738	Scorodite	Arsen.	X=*b*. Y=*a*	2V=Mod. Green: pleo.	139
	1.76	1.76	1.63	*Chalcodite*	Sil.	001⊥X±	2V=Sm. X=yel., Z=br.	435
	1.768	1.768	1.760	Corundum	Ox.	None. X=*c*	Tinted±: X<Z	43
1.77		.016± (or N_g-N_p)		Chloritoid	Sil.	001⊥Z±	2V=50°±. X=green, Y=blue	438
1.77		1.82	1.76	*Piedmontite*	Sil.	001; Y=*b*	2V=55°±. Brown: X<Z	315
1.77		.01 (or N_g-N_p)		*Stibiconite*	Ox.	Z=*c*	G.=5.2. Insol.	68
	1.77	1.78	1.73	**PISTAC. (Epidote)**	Sil.	001. Y=*b*	2V=75°±. X, Z=greenish, Y=golden	314
	1.77	Strong (or N_g-N_p)		*Nordenskioeldite*	Bor.	001⊥X	Yellow±	95
1.770		1.785	1.698	*Holdenite*	Phos.	Y=*b*. Z=*a*	2V=30°. G.=4	136
1.77		1.79	1.765	*Conichalcite*	Arsen.	Z ∥ fib.	2V=25°. X=yel., Z=gr.	136
	1.77	1.782	1.745	**Acmite**	Sil.	110 at 87°	X∧*c*=5°±. 2V=69°±. Brown or green: X>Z	234
	1.771	1.782	1.751	*Leucophenicite*	Sil.	One⊥X	2V=74°. Pink±	412
	1.772	1.772	1.763	Corundum	Ox.	X=*c*	Tinted±: X<Z	43
	1.772	1.772	1.770	*Swedenborgite*	Antim.	0001⊥X	G.=4.29. Insol.	149
	1.773	1.807	1.729	*Margarosanite*	Sil.	010. Tric.	2V=83°. G.=4.0	406
1.774		1.783	1.770	*Barthite*	Arsen.	None	2V=Mod. G.=4.2	160
1.774		1.83	1.770	*Taramellite*	Sil.	Z ∥ fib.	2E=76°. Brown: X<Z	427
1.776		1.795	1.758	*Orientite*	Sil.	X=*a*; Y=*c*	2V=67°. Brown: X>Z	432
	1.778	1.790	1.760	*Leucophenicite*	Sil.	One⊥X	2V=74°. Pink±	412

1.778	1.803	1.730	*Brochantite*	Sul.	010⊥X	Y=*a*. 2V=72°. Gr.: X<Z	102
1.78	1.80	1.77	**Allanite**	Sil.	Y=*b*	2V=Lg. Green: X<Z	316
1.78	1.78	1.65	*Chalcodite*	Sil.	001⊥X±	2V=Sm. Brown: X<Z	435
1.78	1.78	1.57	Ferrodolomite	Carb.	10$\bar{1}$1. X=*c*	G.=3.36±. Efferv. HCl	73
1.78	1.801	1.778	*Conichalcite*	Arsen.	Z ‖ fib.	2V=Sm. X=yel., Z=gr.	136
1.780	1.805	1.776	*Caryinite*	Arsen.	110 at 81°; 010	Z=*b*. 2V=41°. Brown±	122
1.78±	1.785	1.772	*Gadolinite*	Sil.	Z∧*c*=10°±	2V=85°. X<Z Brown or green:	424
1.78+	?	?	*Kasolite*	Sil.	001; X=*b*	2V=39°. Yellow±	442
1.782	1.815	1.752	*Shaituckite*	Sil.	Z ‖ fib.±	2V=Lg. Blue: X<Z	411
1.785	1.79	1.58	*Mesitite*	Carb.	10$\bar{1}$1. X=*c*	G.=3.1±. Efferv. HCl	75
1.785	1.829	1.747	*Olivenite*	Arsen.	X=*a*; Y=*c*	2V=Lg. Green	132
1.785	1.785	1.57	*Pistomesite*	Carb.	10$\bar{1}$1. X=*c*	G.=3.4. Efferv. HCl	75
1.786	1.815	1.775	*Beraunite*	Phos.	100; Z=*b*	2V=Mod. Red: X<Z	144
1.786	1.787	1.761	*Allactite*	Arsen.	010⊥Z	2V=0°±. X=green, Z=yellow	155
1.786	1.804	1.758	*Roepperite*	Sil.	010⊥X	2V=77°. Gel. HCl	194
1.786	1.797	1.759	Tephroite	Sil.	010⊥X	2V=65°. Gel. HCl	194
1.788	1.818	1.783	*Lossenite*	Sul.+	X=*b*; Z=*c*	2V=50°. Red±. Sol. HCl	120
1.788	1.800	1.777	*Retzianite*	Arsen.	Y=*b*; Z=*a*	2V=Lg. Brown: X<Z	154
1.788	1.837	1.787	Monazite	Phos.	001⊥Z±	2V=Sm. Yellow: X<Y	138
1.79	2.05	1.78	*Ferrimolybdite*	Molyb.	001⊥Z	2V=28°. Yellow: X<Z	108
1.79	1.85	1.75	*Uraconite*	Sul.	X=*a*; Z=*c*	2V=Mod. Yellow±	110
1.79±	1.807	1.73	*Pseudomalachite*	Phos.	Z ‖ fib.	2V=50°. Green	135
1.79	.015±		*Ardennite*	Sil.	010⊥Y	2V=Var. Yellow: X>Z	440
1.792±	1.803	1.768	Hortonolite	Sil.	010⊥X	2V=70°. Gel. HCl	192
1.793	1.812	1.784	Scorodite	Arsen.	X=*b*; Y=*a*	2V=70°. Green, pleo.	139
1.793	1.809	1.756	*Thortveitite*	Sil.	110; Y=*b*	2V=66°. X=gr., Z=yel.	211
1.793	1.802	1.780	*Sarkinite*	Arsen.	100; Y=*b*	2V=83°. Pink; yellow	135
1.794	1.803	1.794	*Arseniopleite*	Arsen.	10$\bar{1}$1. Z=*c*	Also biax. Red	153
1.795	1.815	1.780	*Barthite*	Arsen.	None	2V=90°±. Green; pleo.	160
1.80±	1.81±	1.78±	Tephroite	Sil.	010⊥X	2V=Lg. Gel. HCl	194
1.80±	.006		Enigmatite	Sil.	110 at 66°	Z∧c=+45°±. 2V=32. Brown: X<Z	428

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g	N_p	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
	1.77	1.782	1.745	**Acmite**	Sil.	110 at 87°	$X \wedge c = 5° \pm$. $2V = 69° \pm$. Br. or gr: $X < Z$	234
1.785		1.829	1.747	*Olivenite*	Arsen.	$X = a$; $Y = c$	$2V$ = Lg. Green	132
	1.785	1.785	1.57	*Pistomesite*	Carb.	$10\bar{1}1$. $X = c$	Efferv. HCl. G. = 3.4	75
1.788		1.837	1.787	Monazite	Phos.	$001 \perp Z \pm$	$2V$ = Sm. Yellow: $X < Y$	138
1.79		.015±		*Ardennite*	Sil.	$010 \perp Y$	$2V$ = Var. Yellow: $X > Z$	440
1.8±		.01		*Thorite*	Ox.	110 at 90°	$Z = c$. G. = 5.3. Yellow	185
	1.80±	Strong		*Cronstedtite*	Sil.	$001 \perp X \pm$	$2V = 0° \pm$. X = brown, Z = green	285
	1.80	1.80	1.72	*Ferritungstite*	Tung.	Z ‖ fib.	Hex. Yellow±	107
	1.8±	1.8±	1.765	*Cornetite*	Phos.	$X = a$; $Y = c$	$2V = 30° \pm$. Blue	132
	1.80	1.80	1.585	Rhodochrosite	Carb.	$10\bar{1}1$. $X = c$	G. = 3.7±. Efferv. HCl	77
1.801		1.849	1.800	Monazite	Phos.	$001 \perp Z \pm$	$2V$ = Sm. Yellow: $X < Y$	138
1.801		1.834	1.783	*Flinkite*	Arsen.	$Y = c$; $Z = a$	$2V$ = Lg. X = green, Z = brown	154
1.807		1.84	1.79	*Leucochalcite*	Arsen.	$Z = c$?	$2V$ = Lg. Rare	136
1.809		1.830	1.806	*Warwickite*	Bor.	$100 \perp Z$	$2V = 59°$. Brown: $X > Z$	95
	1.81	1.863	1.772	*Olivenite*	Arsen.	$X = a$; $Y = c$	$2V = 82°$. Green	132
1.81±		.030		*Törnebohmite*	Sil.	?	$2V = 30°$. Olive; pleo.	414
	1.81	1.830	1.788	*Hancockite*	Sil.	001	$2V = 50° \pm$. X = pink, Y = brown	316
	1.81	1.81	1.74	*Carphosiderite*	Sul.	$0001 \perp X$	G. = 2.6±. Yellow±	107
	1.81	1.82	1.78	*Knebelite*	Sil.	$010 \perp X$	$2V = 55° \pm$. Gel. HCl	193
1.815±		1.85±	1.81±	*Cornwallite*	Arsen.	Y ‖ fib.	$2V$ = Sm. Green	136
	1.815	1.825	1.775	*Pascoite*	Van.	$010 \perp X$	$2V = 50°$. X = yellow, Z = orange	160
	1.815	1.815	1.761	*Molybdophyllite*	Sil.	$0001 \perp X$	G. = 4.72. Rare	407
	1.817	1.820	1.715	*Jarosite*	Sul.	$0001 \perp X$	Also biax. Yellow	114
1.818		1.821	1.817	*Cerite*	Sil.	None	$2V = 25°$. Reddish±	422
	1.82	1.84	1.78	**Acmite**	Sil.	110 at 87°	$X \wedge c = +5° \pm$. $2V = 60°$. Gr. or br. $X > Z$	234
	1.82	1.82	1.595	*Pistomesite*	Carb.	$10\bar{1}1$. $X = c$	G. = 3.4±. Efferv. HCl	75

1.82	1.82	1.715	*Jarosite*	Sul.	0001⊥X	G.=3.2. Yellow	114
1.82	1.82	1.73	*Carphosiderite*	Sul.	0001⊥X	G.=2.6±. Yellow	107
1.82	1.82	1.595	*Sideroplesite*	Carb.	10$\bar{1}$1. X=*c*	G.=3.7±. Efferv. HCl	75
1.827	1.864	1.792	Iddingsite	Sil.	100⊥X	2V=80°. Brown: X<Z	437
1.83	1.83	1.63	Rhodochrosite	Carb.	10$\bar{1}$1. X=*c*	G.=3.7±. Efferv. HCl	77
1.83±	Strong		*Carminite*	Arsen.	110. Z=*c*?	G.=4.1. Red	154
1.83	1.83	1.61	*Oligonite*	Carb.	10$\bar{1}$1. X=*c*	G.=3.8±. Efferv. HCl	76
1.83	1.83	1.79	*Beaverite*	Sul.	X=*c*	G.=4.36. Yellow	115
1.831	1.846	1.800	*Higginsite*	Arsen.	X=*a*; Z=*c*	2V=90°±. Green; pleo.	132
1.832	1.832	1.750	*Natrojarosite*	Sul.	0001⊥X	G.=3.18. Yellow: X<Z	114
1.838	1.859	1.809	*Linarite*	Sul.	100, 001	2V=80°. Blue: X<Z	104
1.84	1.85	1.81	*Knebelite*	Sil.	010⊥X	2V=55°±. Gel. HCl	193
1.840	1.888	1.792	*Lautarite*	Iod.	011; Y=*b*	2V=90°±. Sol. HCl	89
1.840	1.885	1.830	*Dufrenite*	Phos.	010⊥Z	2V=90°±. X=brown, Z=green	142
1.84	1.85	1.69	*Tagilite*	Phos.	010; X=*c*±	2V=Sm. Green	137
1.840	1.845	1.773	*Chalcosiderite*	Phos.	010⊥X±	2V=24°. Green: X<Z	157
1.84	.03		*Heterosite*	Phos.	001⊥X	2V=Lg. X=brown, Z=violet	141
1.842	1.857	1.825	*Dietzeite*	Chrom.	100⊥X±	2V=86°. Yellow	121
1.849	1.849	1.621	*Smithsonite*	Carb.	10$\bar{1}$1. X=*c*	G.=4.3. Efferv. HCl	78
1.845	1.890	1.840	*Kraurite*	Phos.	010⊥Z	2V=28°. X=yellow, Z=brown or gr.	142
1.846	1.864	1.792	Iddingsite	Sil.	100⊥X	2V=75°±. Brown: X<Z	437
1.848	1.848	1.817	*Högbomite*	Ox.	X=*c*	G.=3.8. Brown: X<Z	65
1.85	1.98	1.84	*Ludwigite*	Bor.	Z ‖ fib.	2V=Sm. X=green, Z=brown	94
1.85±	1.86	1.85	**Zircon** (alt.)	Ox.	Poor	Tet. G.=4.2. Gray	183
1.85	1.86	1.82	**Fayalite**	Sil.	010⊥X	2V=50°±. Gel. HCl	192
1.853	1.853	1.803	*Högbomite*	Ox.	X=*c*	G.=3.8. Brown: X<Z	65
1.855	1.855	1.600	*Spherocobaltite*	Carb.	10$\bar{1}$1. X=*c*	G.=4.1. Efferv. HCl	78
1.86	1.86	1.62	*Sideroplesite*	Carb.	10$\bar{1}$1. X=*c*	G.=3.7±. Efferv. HCl	75
1.86	1.86	1.62	*Oligonite*	Carb.	10$\bar{1}$1. X=*c*	G.=3.8±. Efferv. HCl	76
1.86	1.88	1.82	*Erinite*	Arsen.	One⊥Z	2V=Mod. Green	133
1.861	1.880	1.831	*Atacamite*	Cu, OH, Cl	010⊥X	2V=75°. Green: X<Z	38

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g	N_p (or N_g-N_p)	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.79		.015±		*Ardennite*	Sil.	010⊥Y	2V=Var. Yellow: X>Z	440
	1.83	1.83	1.79	*Beaverite*	Sul.	X=*c*	G.=4.36. Yellow	115
	1.84	.03		*Heterosite*	Phos.	001⊥X	2V=Lg. X=brown, Z=violet	141
	1.85	1.86	1.82	**Fayalite**	Sil.	010⊥X	2V=50°. Gel. HCl	192
1.86		1.92±	1.85±	*Purpurite*	Phos.	001⊥X	2V=38°. X=gray, Z=red	141
	1.86	1.86	1.62	**Siderite**	Carb.	10$\bar{1}$1. X=*c*	G.=3.85. Efferv. HCl	76
	1.866	1.909	1.818	*Caledonite*	Sul.	001⊥Z	2V=85°. Green: Y<Z	120
	1.87	1.87	1.83±	*Beaverite*	Sul.	X=*c*	G.=4.36. Yellow±	115
	1.87	1.88	1.750	Becquerelite *	Ox.	001⊥X	2V=Sm. Yellow: X<Z	60
1.87		1.90	1.86	*Synadelphite*	Arsen.	X∧*c*=45°	2V=Sm. Brown	155
	1.870	1.870	1.792	*Arseniosiderite*	Arsen.	001⊥X	Also biax. X=yellow, Z=brown	153
	1.87	1.91	1.73	*Clinoclasite*	Arsen.	001⊥X±	2V=53°. Green; pleo.	135
	1.870	1.895	1.670	*Tyuyamunite*	Van.	001⊥X	2V=45°±. Yellow: X<Z	147
	1.875	1.875	1.633	**Siderite**	Carb.	10$\bar{1}$1. X=c	G.=3.89. Efferv. HCl	76
	1.875	1.909	1.655	Malachite	Carb.	001⊥X±	2V=43°. Green: X<Z	83
	1.875±	1.875	1.785	*Plumbojarosite*	Sul.	10$\bar{1}$1. X=*c*	Also biax. X=yellow, Z=red	115
1.879		2.057	1.817	*Uvanite*	Van.	Two pinac.	2V=52°. Y=brown, Z=yellow	148
	1.88	1.89	1.84	**Fayalite**	Sil.	010⊥X	2V=47°. Gel. HCl	192
1.88		1.93	1.87	*Hemafibrite*	Arsen.	010⊥X	2V=35°. Red-brown	135
	1.88	Mod.		*Chenevixite*	Arsen.	?	Green, yellow	156
	1.88	.01		*Chevkinite*	Sil.	Z=*b*	2V=Mod. Brown: X<Z	423
1.883		1.895	1.878	Anglesite	Sul.	001⊥X	2V=70°±. G.=6.3	99
	1.89±	1.91	1 86	*Heterosite*	Phos.	001⊥X	2V=Lg. X=brown, Z=red	136
	1.89	Strong		Ilvaite	Sil.	001⊥Z	2V=Sm. X=brown, Z=green	141
1.894		1.996	1.888	**Titanite**	Sil.	110 at 66°	Y=*b*. 2V=Sm. $\rho>v$, strong	204
	1.895	1.92	?	*Carnotite*	Van.	001⊥X	2V=40°±. Yellow±	148

1.898	1.898	1.815	*Mazapilite*	Arsen.	X=*c*	2V=0°±. Brown: X<Z	156
1.90	2.12	1.90	*Trippkeite*	Arsen.	100. Z=*c*	Tet. Blue-green	159
1.9±	?	?	*Katoptrite*	Sil.	100⊥Z±?	2V=25°. Red-brown	441
1.910	1.945	1.910	*Ganomalite*	Sil.	0001⊥Z	G.=5.6. Gel. HCl	407
1.910	1.977	1.89±	*Schultenite*	Phos.	010⊥X	Z∧*c*=+66°. G.=5.94	123
1.91	.01		*Daubréeite*	Bi, OH, Cl	?	G.=6.4. Sol. HCl	39
1.91	Strong		*Cervantite*	Ox.	Z ∥ fib.	G.=4	67
1.915	Weak		*Huegelite*	Van.	010?	2V=Sm. Yellow: X<Y	127
1.917	1.927	1.917	*Nasonite*	Sil.	0001⊥Z	G.=5.4. Gel. HCl	407
1.918	1.934	1.918	Scheelite	Tung.	111	G.=6.1. Dec. HCl	97
1.92	Strong		Ilvaite	Sil.	001⊥Z	2V=Sm. X=brown, Z=green	431
1.92	1.92+	1.85	*Purpurite*	Phos.	001⊥X	2V=38°. X=gray, Z=red	141
1.92	2.01	1.87	*Claudétite*	Ox.	010⊥Y	2V=58°. Z∧*c*=6°	45
1.920	1.956	1.885	*Tsumebite*	Phos.	001?	2V=89°. Green: X<Z	137
1.92	?	?	*Calciovolborthite*	Van.	One	Extr. disp.	135
1.923	1.968	1.923	**Zircon**	Ox.	Z=*c*	G.=4.7. White, gray, brown	183
1.93±	1.96	1.85	*Chapmanite*	Sil.	Z ∥ laths	G.=3.58. Olive green±	440
1.93	Weak		*Corkite*	Sul.	0001⊥X	Also biax. Abn. int. colors	119
1.952	1.968	1.80	*Tyuyamunite*	Van.	001⊥X	2V=45°±. Yellow: X<Z	147
1.935	2.05	1.92	**Titanite**	Sil.	110 at 66°	Y=*b*. 2V=Sm., $\rho>v$, strong	204
1.935	2.03	1.92	*Keilhauite*	Sil.	110 at 66°	Y=*b*. 2V=50°±, $\rho>v$, strong. Br., pleo.	205
1.94	1.95	1.71	*Durdenite*	Tel.	001⊥X	2V=Sm. Yellow: X<Z	118
1.945	1.971	1.945	*Nasonite*	Sil.	0001⊥Z	G.=5.4. Gel. HCl	407
1.95	1.96	1.92	*Manganostibite*	Antim.	010⊥X	2V=Sm. X=brown, Z=dark	155
1.955	1.965	1.702	*Durdenite*	Tel.	001⊥X	2V=23°. Yellow: X<Z	118
1.960	2.015	1.960	**Zircon**	Ox.	Z=*c*	G.=4.7. White, gray, brown	183
1.96	?	1.96	*Dixenite*	Arsen.+	0001⊥Z	G.=4.2. Yellow	161
1.96	Mod.		*Beudantite*	Sul.+	0001⊥X	Also biax. Abn. disp.	119
1.961	1.968	1.947	*Alamosite*	Sil.	010⊥Y	2V=65°. Gel. HNO_3	401

* Indices as given by V. Billiet: *Bull. Soc. Fr. Min.*, XLIX, 1926, p. 136.

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +		−	N_g or N_g-N_p	N_p	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.79			.015+		*Ardennite*	Sil.	010⊥Y	2V=Var. Yellow: X>Z	440
		1.895	1.92	?	*Carnotite*	Van.	001⊥X	2V=40°±. Yellow	148
	1.91		Strong		*Cervantite*	Ox.	Z ‖ fib.	G.=4	67
1.963			1.966	1.963	*Hyalotekite*	Sil.	Two at 90°	2V=Sm. G.=3.8	422
1.967			1.978	1.967	*Powellite*	Molyb.	111. Z=*c*	Tet. G.=4.4	98
1.97			1.99	1.95	*Bayldonite*	Arsen.	Z∧*c*=45°	2V=Lg. Green	137
1.973			2.656	1.973	*Calomel*	Hal.	100	G.=6.48. Extr. biref.	30
		1.975	2.005	1.871	*Walpurgite*	Arsen.	010?	2V=52°. Yellow±	148
		1.98	1.98	?	*Diaboléite*	Hal.	001⊥X	G.=6.4. Blue: X<Z	37
1.985			2.05	1.955	*Uranospherite*	Uran.	100⊥X	2V=Lg. Yellow±	109
		1.99	2.01	1.93	*Lanarkite*	Sul.	001⊥X±	2V=47°. G.=6.6±	102
	1.99		Weak		*Parsonsite*	Phos.	Z∧*c*=12°	G.=6.23. Brown±	148
1.99			Weak		*Agricolite*	Sil.	Fibers	2V=Lg. Yellow±	414
1.997			2.093	1.997	Cassiterite	SnO_2	110 at 90°	Z=*c*. Tet. Brown±, etc.	52
2.0			.02±		*Ardennite*	Sil.+	010, 110	2V=Var. Yellow: X>Z	440
	2±		Strong		*Pseudocotunnite*	Hal.	Z=*c*	Sol. H_2O. Yellow±	33
		2±	Mod.		Graphite	C	0001⊥X	G.=2.25. Opaque	14
		2.00	2.00	1.82	*Bismite*	Ox.	0001⊥X	G.=4.36. Sol. HNO_3	43
		2.00	2.01	1.87	*Leadhillite*	Sul.	001⊥X±	2V=10°. Ps. Hex. twin.	120
2.008			2.029	2.008	Zincite	ZnO	0001⊥Z	G.=5.5±. Red	41
		2.01	2.03	1.9±	*Walpurgite*	Arsen.	010?	2V=52°. Yellow±	148
		2.01	2.02	2.00	*Volborthite*	Van.	One⊥Bx.	2V=Var. Green±	137
2.03			Weak		*Agricolite*	Sil.	Fibers	2V=Lg. Yellow	414
2.03			Mod.		*Voltzite*	Zn_5OS_4	Z=*c*	G.=3.7. Yellow±, etc.	28
		2.03	2.03	2.00	*Pseudoboléite*	Hal.	001⊥X	G.=4.85. Blue	37
2.038			2.245	1.958	Sulfur	S	X=*a*; Z=*c*	2V=69°. Yellow±	14

2.04	.02±		*Boléite*	Hal.	001⊥X	G. = 4.9±. Blue	37
2.041	2.041	1.926	*Cumengéite*	Hal.	101. X = *c*	G. ± 4.8. Blue	37
2.05	2.10	2.01	*Calciovolborthite*	Van.	?	2V = 83°. Green±. Extr. disp.	135
2.05	Strong		*Fernandinite*	Van.	Fibers	Green; not pleo.	148
2.05	2.065	1.908	*Pinakiolite*	Bor.	010⊥X	2V = 32°. Brown: X > Z	94
2.06	Weak		*Cervantite*	Ox.	Fibers	Data vary. G. = 4	67
2.061	2.061	2.049	Pyromorphite	Phos.	X = *c*	2V = 0°±. Colorless or X = yel., Z = gr.	131
2.07	2.08	2.06	*Carnotite*	Phos.	001⊥X	2V = 50°±. Yellow±	148
2.07	2.07	2.05	*Barysilite*	Sil.	0001⊥X	G. = 6.7. Gel. HNO_3	401
2.074	2.076	1.803	Cerussite	Carb.	110 at 63°	X = *c*. 2V = 9°. G. = 6.57. Efferv. HCl	80
2.08	2.08	1.82	*Bindheimite*	Antim.	Prism.	2V = 0°. G. = 4.8±	160
2.09	2.09	2.07±	*Boléite*	Hal.	001⊥X	G. = 4.9±. Blue	37
2.09	2.10	1.95	*Emmonsite*	Tel.	010⊥Y	2V = 20°. Sol. HCl	118
2.09	2.09	1.94	*Hydrocerussite*	Carb.	0001⊥X	G. = 6.8. Efferv. HCl	82
2.09	.01±		*Montanite*	Tel.	One? ⊥X	2V = Sm. Abn. int. colors	109
2.1±	Dist.		*Georgiadesite*	Arsen.	X = *b*; Z = *c*	2V = Lg. G. = 7.1	133
2.1±	2.16	2.08	*Trigonite*	Arsen.	010⊥Y	Ext. in 010 at 45°	159
2.10	2.23	1.70	*Metahewettite*	Van.	Z ‖ elong.	2V = 52°. X = yellow, Z = red	160
2.10	2.11	2.05	**Goethite**	Ox.	010⊥X	2V = Sm. Yellow: *a* > *b*	47
2.102	2.126?	1.816	*Fiedlerite*	Hal.	100⊥X±	Z = *b*. G. = 5.88	39
2.116	2.158	2.077	*Laurionite*	Hal.	100⊥X	2V = 82°. G. = 6.24	38
2.118	2.145	2.118	*Phosgenite*	Carb.	110, 100	G. = 6.1±. Sol. HNO_3	85
2.13	2.21	2.13	*Penfieldite*	Hal.	0001⊥Z	Sol. HNO_3	38
2.13	2.13	1.94	*Bismutospherite*	Carb.	One? ⊥X	G. = 7.3. Efferv. HCl	86
2.135	2.135	2.120	*Mimetite*	Arsen.	X = *c*	Also biax. Yellow: X < Z	132
2.146	Strong		*Paralaurionite*	Hal.	001; Y = *b*	Violet±: Y > Z	39
2.15	2.15	2.135	*Mimetite*	Arsen.	X = *c*	Also biax. Colorless or yellow: X < Z	132
2.15	2.18	2.14	*Atelestite*	Arsen.	001	2V = 44°. Yellow±	143
2.15	Strong		*Cuprotungstite*	Tung.	One	Green. Dec. HCl	105
2.15	2.15	2.04	*Matlockite*	Hal.	001⊥X	Also biax. G. = 7.2	37

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g	N_p	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
	2.10	2.11	2.05	**Goethite**	Ox.	010⊥X	2V=Sm. Yellow: *a*>*b*	47
	2.15	.05±		*Bismutite*	Carb.	Z ‖ fib.	2V=Mod. Efferv. HCl	86
	2.16	2.16	2.14	*Bellite*	Arsen.+	X ‖ fib.	Yellow: X<Z	119
2.17		2.31	2.12	*Melanotekite*	Sil.	Two	2V=67°. Brown: X<Z	427
	2.18 Li	2.35	2.00	*Tellurite*	Ox.	010⊥X	2V=90°±. G.=5.9	59
	2.18	2.35	1.77	*Hewettite*	Van.	Z ‖ elong.	2V=Mod. Red: X<Z	160
	2.18	2.18	2.16	*Kleinite*	Hal.	Tr.?	2V=Sm. Sol. HCl	38
2.18		.01±		*Iodyrite*	Hal.	0001⊥Z	Abn. int. colors	30
2.19		2.21	2.19	*Kleinite*	Hal.	0001⊥Z	G.=7.98. Sol. HCl	38
	2.19	2.20	2.13	*Baddeleyite*	Ox.	001⊥X±	2V=30°. Brown: X>Z	60
2.20		2.31	2.10	*Kentrolite*	Sil.	110 at 65°	X=*a*. 2V=88°. Brown: X<Z	427
2.20		2.51	1.94	*Lepidocrocite*	Ox.	010⊥X	2V=83°; Red: X<Z	48
2.20		2.33	2.19	*Tripuhyite*	Antim.	?	2V=Sm. Yellow	160
2.21		2.22	2.21	*Iodyrite*	Hal.	0001⊥Z	Abn. int. colors	30
2.217		2.260	2.199	*Cotunnite*	Hal.	001⊥Z	2V=67°. G.=5.84	32
2.22		2.32	2.17	Huebnerite	Tung.	010⊥X	2V=73°. Green or brown: X<Z	101
	2.22	2.22	2.11	*Vauquelinite*	Chrom.	X ‖ fib.±	2V=Sm. Colorless or X=gr., Z=br.	121
	2.24	2.26	2.09	*Tungstite*	Ox.	001⊥X	2V=Sm. Yellow	60
2.25 Li		2.53	2.25	*Manganite*	Ox.	010⊥Y	2V=Sm. Brown: X<Z	48
	2.25	2.25	2.20	*Endlichite*	Arsen.	X=*c*	Yellow±	132
2.25±		2.34	2.19	*Mangantantalite*	Tan.	100	2V=Lg. Red: X<Z	165
	2.26	.13±		*Cuprodescloizite*	Van.	X ‖ fib.	2V=60°. Brown: X<Z	133
	2.26	2.26	2.10	*Heterolite*	Ox.	001⊥X	G.=4.8. Brown: X>Z	65
	2.265	2.35	2.185	*Descloizite*	Van.	X=*c*; Z=*a*	2V=Lg. Yellow: X<Z	133
	2.269	2.269	2.182	*Stolzite*	Tung.	001⊥X	G.=8±. Dec. HNO_3	98
2.27 Li		2.42	2.27	*Tapiolite*	Tant.	Z=*c*	G.=7.5±. Brown: X<Z	164

2.27	2.30	2.27	*Raspite*	Tung.	100; Y=*b*	2V=Sm. Yellow: X<Z	101
2.27	2.31	2.24	*Mendipite*	Hal.	110; 010	X=*a*. 2V=90°±. Z ‖ elong.	38
2.28	.05±		*Bismutite*	Carb.	Z ‖ fib.	2V=Mod. Efferv. HCl	86
2.295	2.295	2.285	*Finnemanite*	Arsen.	$10\bar{1}1$	G.=7.26. Olive	159
2.30 Li	2.40	2.30	*Hjelmite*	Tant.	?	2V=Sm. Brown: X<Z	166
2.3 Li	2.3	?	*Plattnerite*	Ox.	X=*c*	G.=8.5. Brown	53
2.31	2.33	2.21	*Cuprodescloizite*	Van.	X ‖ fib.	2V=60°. Brown: X<Z	133
2.31	2.31	1.95	*Geikielite*	Ox.	$10\bar{1}1$. X=*c*	G.=3.9. Purple	67
2.32± Li	2.42	2.26	Wolframite	Tung.	010⊥X	Often opaque	101
2.32±	2.43	2.26	*Tantalite*	Tant.	100	2V=Lg. Red: X<Z	165
2.32 Li	2.32	2.25	*Ecdemite*	Arsen.	001⊥X	Also biax. Yellow±	159
2.34	2.34	2.14	*Heterolite*	Ox.	001⊥X	G.=4.85. Brown: X>Z	65
2.35	2.35	2.31	*Endlichite*	Van.	X=*c*	Also biax. Yellow±	132
2.35 Li	2.40	2.30	*Nadorite*	Antim.	100⊥X	2V=Lg. Yellow±	159
2.35 Li	2.36	2.25	*Schwartzembergite*	Hal.	001⊥X	2V=Sm. Yellow±	38
2.35	2.35	2.18	*Valentinite*	Ox.	010⊥Z	2V=Sm. Sol. HCl	45
2.35	2.35	2.33	*Lorettoite*	Hal.	001⊥X	G.=7.5. Yellow±	38
2.354	2.354	2.299	Vanadinite	Van.	X=*c*	Yellow±: X<Z	131
2.356	2.378	2.356	*Wurtzite*	ZnS	X ‖ fib.	G.=4.0. Yellow: X>Z	20
2.36 Li	2.48	2.28	*Brackebuschite*	Van.	?	2V=Lg. Brown: X<Z	125
2.36 Li	2.36	2.31	*Langbanite*	Ox.?	X=*c*	G.=4.7. Brown: X<Z	66
2.36± Li	2.375	2.35	*Pseudobrookite*	Ox.	001⊥X	2V=50°. Brown: Y>Z	165
2.37 Li	2.66	2.31	*Crocoite*	Chrom.	110 at 86°	Y=*b*. Z∧*c*=−6°. 2V=57°. Orange±	101
2.38 Li	2.65	2.34	*Phenicochroite*	Chrom.	One	2V=Mod. Red	100
2.39 Li	2.42	2.38	*Pseudobrookite*	Ox.	001⊥X	2V=50°. Brown: Y>Z	165
2.394	2.400	2.260	**Goethite**	Ox.	010⊥X	2V=Sm. Yellow: *a*>*b*	47
2.40	2.40	2.37	*Lorettoite*	Hal.	001⊥X	G.=7.5. Yellow±	38
2.40± Li.	Extr.		Columbite	Colum.	100	2V=Lg. Opaque±	165
2.40 Li	Weak		*Minium*	Ox.	X ‖ elong.	Red: X>Z. Abn. int. colors	65
2.40 Li	Strong		*Ferberite*	Tung.	010⊥X	Nearly opaque	101

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g	N_p (or N_g-N_p)	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
2.356		2.378	2.356	*Wurtzite*	ZnS	X ‖ fib.	G.=4.0. Yellow: X>Z	20
	2.402 Li	2.402	2.304	Wulfenite	Molyb.	111; X=*c*	Also biax. G.=6.9	98
2.404		2.457	2.374	*Stibiotantalite*	Tant.	100⊥X	2V=75°. Yellow±	167
2.419		2.459	2.398	*Stibiocolumbite*	Colum.	100⊥X	2V=73°. Yellow±	167
2.45 Li		2.51	2.45	*Derbylite*	Titan.	?	2V=0°±. G.=4.5. Brown	162
	2.45± Li	Strong		*Mangancolumbite*	Colum.	100	2V=Lg. Opaque±	165
2.46		2.48	2.46	*Wurtzite*	ZnS	X ‖ fib.	G.=4.0. Yellow: X>Z	20
	2.46 Li	2.46	2.15	*Hausmannite*	Ox.	001⊥X	G.=4.8. Dark brown	64
	2.481	2.481	2.210	*Pyrophanite*	Ox.	02$\bar{2}$1. X=*c*	G.=4.5. Red	67
2.50 Li		2.65	2.37	*Montroydite*	Ox.	010⊥Z	2V=Lg. Yellow±	41
2.50 Li		Mod.		*Strueverite*	Tit.	?	G.=5.56. O=brown, E=green	164
	2.50 Li	Mod.		*Senaite*	Ox.	?	G.=5±. Opaque±	67
	2.50 Li	2.51	2.41	*Pucherite*	Van.	001⊥X	2V=19°. Brown±	138
	2.5	2.5	2.3	*Hydrohematite*	Ox.	X ‖ fib.	G.=4.5–5. Red±	45
2.506		2.529	2.506	*Greenockite*	CdS	10$\bar{1}$0	G.=4.8. Yellow±	21
	2.534	2.534	2.489	*Octahedrite*	TiO_2	001⊥X	Yellow or blue: X<Z	53
2.55 Li		Strong		*Koechlinite*	Molyb.	100⊥Z	2V=Lg. Yellow±	107
	2.564	2.564	2.497	*Octahedrite*	TiO_2	001⊥X	Yellow or blue: X<Z	53
2.582		Weak		*Greenockite*	CdS	10$\bar{1}$0	Also. biax. G.=4.8. Yellow±	21
2.585		2.705	2.583	*Brookite*	TiO_2	Z=*a*	2V=30°. Brown: X<Z	59
	2.59 Li	2.61	2.46	Realgar	AsS	010⊥Y	2V=40°. Red; pleo.	22
	2.6 Li	Extreme		*Trechmannite*	$AgAsS_2$	10$\bar{1}$1; 0001⊥X	Red: X<Z	27

2.603	2.889	2.603	**Rutile**	TiO_2	110 at 90°	Z=*c*. G.=4.2. Brown: X<Z	50
2.61 Li	2.71	2.51	*Massicotite*	PbO	100⊥Y	2V=Lg. Yellow: X<Z	41
2.616	2.903	2.616	**Rutile**	TiO_2	110 at 90°	Z=*c*. G.=4.2. Brown: X<Z	50
2.62 Li	Mod.		*Arizonite*	Tit.	?	Nearly opaque red	68
2.64 Li	2.64	2.51±	*Lithargite*	PbO	110 at 90°	X=*c*. G.=9.1. Yellow±	41
2.64 Li	2.66	2.35	*Terlinguaite*	Hg_2OCl	$\bar{1}01$	2V=20°. G.=8.7	39
2.654	2.697	2.654	*Moissanite*	SiC	Z=*c*	Tinted±. Str. dispersion	17
2.665	2.665	2.535	*Lithargite*	PbO	110 at 90°	X=*c*. G.=9.1. Yellow±	41
2.7 Li	2.7	2.6	*Hydrohematite*	Ox.	X ‖ fib.	G.=4.5–5. Red±	45
2.72+ Li	Extreme		Orpiment	As_2S_3	010⊥X	2E=70°. Yellow±: X>Z	25
2.72+ Li	Extreme		*Lorandite*	$TlAsS_2$	100; 001⊥X±	Y=*a*±. 2E=Lg. Red; pleo.	28
2.72+ Li	Strong		*Miargyrite*	$AgSbS_2$	010	Nearly opaque red	27
2.72+ Li	Extreme		*Chalcophanite*	Ox.	0001⊥X	G.=3.9. X=red, Z=opaque	66
2.74+ Li	Extreme		*Kermesite*	Sb_2S_2O	100, 101	2V=Sm. Red: X>Z	28
2.84	Strong		*Tenorite*	CuO	111, $1\bar{1}1$, 001	X=brown, Z=opaque±	41
2.913	3.272	2.913	Cinnabar	HgS	$10\bar{1}1$	G.=8.17. Red. Extr. disp.	21
3±	Extreme		*Livingstonite*	$HgSb_4S_7$	110 at 90°	Z=*c*. Nearly opaque red	28
3±	Strong		*Polybasite*	Ag,Sb,S	X=*c*±. Y=*a*±	2E=70°. Red. G.=6.1	27
3.084 Li	3.084	2.881	Pyrargyrite	Ag_3SbS_3	$10\bar{1}1$. X=*c*	G.=5.8. Red	27
3.087 Li	3.087	2.792	Proustite	Ag_3AsS_3	$10\bar{1}1$. X=*c*	G.=5.7. Red; pleo.	27
3.176	3.188	3.078	*Hutchinsonite*	Tl,Pb,As,S	100⊥Y	G.=4.6. Red; pleo.	28
3.22	3.22	2.94	**HEMATITE**	Fe_2O_3	X=*c*	G.=5.2. Red to opaque	44
3.27?	?	?	*Smithite*	$AgAsS_2$	100; Y=*b*	G.=4.9. Red	27
4.046 Li	4.303	3.194	Stibnite	Sb_2S_3	010⊥Z	Red to opaque	25
4.7±	?	?	Molybdenite	MoS_2	0001⊥X	G.=4.7±. Opaque	26
Extr.	Extreme		**Ilmenite**	$FeTiO_3$	?	G.=4.8±. Opaque	66
Extr.	Extreme		*Chloroxiphite*	Hal.	001⊥X±	Y=brown; Z=green	39

SUPPLEMENTARY TABLE IV B.—REFRINGENCE OF ANISOTROPIC MINERALS

N_o or N_m +	N_o or N_m −	N_g or N_g–N_p	N_p	Mineral	Chem.	Cleavage, Opt. Orient.	Other Characters	Page
1.301		1.307	1.301	*Ferrucite*	$NaBF_4$	X = *c*	G. = 2.50. Sol. H_2O	*
1.348		1.350	1.346	*Bakerite*	Hal.	Two cleav.	G. = 2.96	**
	1.406	1.406	1.391	*Cryptohalite*	Hal.	0001 ⊥ X	G. = 2.15	36
	1.432	1.435	1.427	*Jarlite*	Hal.	X ∧ ⊥ 100 = −16°	G. = 3.93. 2V = 79°	***
1.454		1.491	1.445	*Mercallite*	Sul.	?	G. = 2.31	*4
1.461		1.474	1.461	*Tincalconite*	Bor.	Rhom.	G. = 1.88	90
1.470		1.484	1.461	*Lapparentite*	Sul.	Mono.	2V = 80° calc.	*5
1.482		1.486	1.481	*Ashtonite*	Sil.	001, 110?	Fibrous	432
	1.486	1.488	1.465	*Burkeite*	Carb.-Sul.	X = *c*. Y = *a*	G. = 2.57	*6
1.487		1.540	1.470	*Ammonioborite*	Bor.	Ext. Ang. = 10° ±	2V = 60° ± 10°	91
	1.488	1.504	1.47 ±	*Inderite*	Bor.	X = *b*. Z ∧ *c* = 5°	G. = 1.79	*7
	1.489	1.489	1.486	*Wischnewite*	Sil.	10$\bar{1}$0. X = *c*	May show twinning	30
1.492		1.504	1.490	*Lapparentite*	Sul.	Y = *b*. X ∧ *c* = −5°	2V = 55°	*5
	1.495	1.497	1.445	*Burkeite*	Carb.-Sul.	X = *c*. Y = *a*	No cleavage	*6
	1.500	1.586	1.380	*Nahcolite*	Carb.	101, 111	X ∧ *c* = +27.5°	*8
	1.502	1.502	1.449	*Ungemachite*	Sul.	0001 ⊥ X	G. = 2.29	*9
	1.506	1.529	1.423	*Nesquehonite*	Carb.	110. Y = *c*	G. = 1.85	84
	1.52	1.526	1.501	*Letovicite*	Sul.	X ∧ *c* = 17½°. Z = *b*	G. = 1.81	97
1.524		1.577	1.517	*Ginorite*	Bor.	010 ⊥ Y	2V = 42°. X ∧ elong. = 51°	*10
1.530		1.580	1.515	*Earlandite*	Cit.	?	2V = 60° calc. G. = 1.95	*11
1.534		1.538	1.531	*Minyulite*	Phos.	110. X = *c*	G. = 2.45	*12
1.536		1.545	1.536	*Ashcroftine*	Sil.	100, 001	G. = 2.61	*13
	1.542	1.544	1.535	*Foshallasite*	Sil.	X ⊥ cleav.	G. = 2.5	*14

1.542	1.542	1.489	*Dakeite*	Sul.-Carb.	001⊥X	G. = 2.51. Yellow: X<Y=Z	*15
1.543	1.558	1.534	*Gordonite*	Phos.	010, 100	$Z \wedge c = -26°$	157
1.548	1.548	1.518	*Fluoborite*	Bor.	Hex.	G. = 2.9	92
1.553	1.621	1.551	*Veatchite*	Bor.	010⊥Y	2V = 37°. $Z \wedge c = -38°$	*16
1.553	1.570	1.485	*Alumohydrocalcite*	Carb.	100, 010	Ext. Ang. = 10° on fibers	88
1.553	1.557	1.535	*Hydrocalumite*	Ox.	001⊥X±	2V = 24°	*17
1.556	1.645	1.556	*Julienite*	CSN+	Tetrag.	G. = 1.65	*18
1.558	1.581	1.544	*Louderbackite*	Sul.	Two good cleav.	G. = 2.19. Sol. in H_2O	116
1.566	1.566	1.528	*Fluoborite*	Bor.	Hex.	G. = 2.9	92

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SUPPLEMENTARY TABLE IV B.—REFRINGENCE OF ANISOTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g	N_p or N_g–N_p	Mineral	Chem.	Cleavage, Opt. Orient.	Other Characters	Page
	1.570	1.574	1.559	*Saléite*	Phos.	001⊥X. 010	2V=61°. G.=3.1	*
1.572		1.572	1.570	*Englishite*	Phos.	001⊥X	G.=2.65	158
1.575		1.634	1.543	*Metasideronatrite*	Sul.	001, 010, 100	Y=*b*; Z=*c*. Yellow: X<Y<Z	**
	1.575	1.575	1.547	*Portlandite*	$Ca(OH)_2$	0001⊥X	G.=2.23	***
	1.581	1.586	1.559	*Skolite*	Sil.	001⊥X±	2V=0°–85°	*4
	1.581	1.581	1.565	*Schuchardtite*	Sil.	001⊥X	X=*bluish green*, Z=olive green	*5
	1.587	1.595	1.578	*Leightonite*	Sul.	X∧*b*=3°–5°	G.=2.95	*6
1.590		1.599	1.590	*Wardite*	Phos.	001⊥Z	G.=2.81	158
1.590		1.597	1.587	*Bultfonteinite*	Sil.	100	Z′∧*c* on 010=28°	*7
	1.598	1.602	1.584	*Millisite*	Phos.	X ‖ Elong.	G.=2.83	158
	1.600	1.600	1.586	*Dehrnite*	Phos.	0001⊥X	G.=3.0	151
	1.601	1.601	1.591	*Dennisonite*	Phos.	0001⊥X	G.=2.85	155
	1.605	1.607	1.601	*Tuhualite*	Sil.	001, 100, 010	X=*a*. Y=*b*	*8
1.605		1.613	1.600	*Hydrophilite*	Hal.	110	Lam. twinning	32
1.606		1.621	1.597	*Scawtite*	Sil.	Z∧*a*=29°	G.=2.77	442
	1.607	1.607	1.588	*Schuchardtite*	Sil.	001⊥X	X=*bluish green*, Z=olive green	*5
	1.614	1.631	1.600	*Monetite*	Phos.	001, 110	G.=2.92	123
	1.615	1.629	1.600	*Lehiite*	Phos.	Lg. Ext. Ang.	G.=2.89	158
1.622		1.630	1.622	*Garnierite*	Sil.	Z ‖ Elong.	2V=0°–10°	*9
1.623		1.663	1.591	*Szomolnokite*	Sul.	X∧*c*=+26°	Y=*b*. G.=3.05	*10
	1.623	1.624	1.613	*Lewistonite*	Phos.	0001⊥X	G.=3.06	151
1.630		1.684	1.623	*Guildite*	Sul.	001, 100	G.=2.72	117
	1.631	1.633	1.620	*Parawollastonite*	Sil.	100, $\bar{1}02$, 001	Z∧*c*=−34°	*11

1.635	1.652	1.617	*Tilleyite*	Sil.	100. $X \wedge c = 18°$	G. = 2.84	*12
1.636	1.647	1.636	*Woodhouseite*	Sul.	$0001 \perp Z$	G. = 3.01	*13
1.636	1.664	1.630	*Hilgardite*	Bor.	$010 \perp Y$	$Z \wedge c = 1.5°$. G. = 2.71	*14
1.636	1.636	1.615	*Mitscherlichite*	Hal.	$X = c$	G. = 1.4	34
1.64±	0.01±		*Boehmite*	Ox.	$010 \perp Z$	$110 \wedge 1\bar{1}0 = 63°$	46
1.641	1.647	1.640	*Juanite*	Sil.	Z ‖ Elong.	Fibrous	*15
1.641	1.650	1.641	*Deltaite*	Phos.	$Z = c$	G. = 2.95	155
1.642	1.657	1.632	*Collinsite*	Phos.	Four cleav.	G. = 2.95	128
1.642	1.646	1.575	*β-Ascharite*	Bor.	X ‖ Elong.	G. = 2.65	*16

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SUPPLEMENTARY TABLE IV B.—REFRINGENCE OF ANISOTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g	N_p (or N_g–N_p)	Mineral	Chem.	Cleavage. Opt. Orient,	Other Characters	Page
	1.643	1.657	1.553	*Castanite*	Sul.	010⊥X±	Y=yellow, Z=brownish red	110
1.643		1.695	1.631	*Ransomite*	Sul.	Perf. cleav.	G.=2.63	116
	1.647	1.647	1.637	*Aminoffite*	Sil.	001⊥X	G.=2.94	*
1.648		1.676	1.637	*Loseyite*	Carb.	Y ǁ Elong.	2V=64°	84
	1.655	1.655	1.650	*Ellestadite*	Sil. etc.	X ǁ Elong.	G.=3.07	**
	1.660	1.663	1.648	*Roweite*	Bor.	X=*a*; Y=*c*	2V=15°. G.=2.92	***
1.662		1.663	1.662	*Cahnite*	Arsen.	Tetrag.	G.=3.16	161
	1.663	1.665	1.640	*Seamanite*	Phos.	Y=*b*; Z=*c*	G.=3.13	161
	1.663	1.737	1.598	*Parabutlerite*	Sul.	Y=*c*; Z=*a*	X=yellow; Z=greenish yellow	*4
1.664		1.688	1.660	*Sérandite*	Sil.	001, 100	X∧*a*=−57°	418
	1.667	1.667	1.655	*Cuprosklodowskite*	Sil.	001⊥Y	Gel. with HCl	*5
	1.674	1.731	1.604	*Butlerite*	Sul.	010	X=brown-yellow, Z=canary yellow	108
1.676		1.683	1.672	*Acrochordite*	Arsen.	Y∧*c*=40°–45°	X=*b*. G.=3.19	137
1.685		1.745	1.646	*Antofagastite*	Hal.	110, 001	2V=75°. X=green, Z=blue	*6
	1.686	1.696	1.665	*β-Uranotile*	Sil.	Z∧*c*=41°	Yellow; X<Y=Z	*7
1.690		1.735	1.675	*Legrandite*	Arsen.	Z∧*c*=−38°	X=*b*. G.=4.01	137
	1.692	1.692	1.640	*Bandylite*	Bor.	001⊥X	O=deep blue, E=yellow	*8
1.70±		1.73±	1.70±	*Erikite*	Phos.	?	G.=3.78	*9
	1.7±	0.008		*Tawmawite*	Sil.	001, 100	X=green, Y=yellow, Z=green	*10
1.704		1.719	1.694	*Roselite*	Phos.	010⊥Y; X∧*a*=1°	Pink: X=Y>Z	127
1.713		1.724	1.708	*Repossite*	Phos.	?	G.=3.74	*11
1.715		1.730	1.707	*Larnite*	Sil.	X∧*c*=13°	Z=*b*	194
1.718		1.734	1.709	*Metahohmanite*	Sul.	?	X=yellow; Z=brown	*12

1.719		1.738	1.710	*Johannsenite*	Sil.	110	$Z \wedge c = 48°$	*13
1.719		1.733	1.719	*Bromellite*	Ox.	$10\bar{1}0$	G. = 3.02	*14
	1.725	1.748	1.687	*Bermanite*	Phos.	001 ⊥ X	X = red, Y = yellow, Z = red	*15
1.728		1.735	1.725	*Roselite*	Phos.	010 ⊥ X	$Y \wedge a = 12°$–$20°$	*16
	1.728	1.735	1.720	*Landesite*	Phos.	010 ⊥ Z	X = **brown,** Y = *brown*, Z = yellow	156
	1.728	1.732	1.720	*Varulite*	Phos.	001, 010	Y = *b*. G = 3.58	*17
1.732		1.805	1.714	*Lopezite*	Chrom.	010, 100, 001	Sol. in H_2O	*18
	1.734	1.736	1.723	*Gageite*	Sil.	Z ‖ elong.	G. = 3.58	*19
	1.736	1.739	1.715	*Renardite*	Phos.	001 ⊥ X	Y = *c*; G. = 4.+	148

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SUPPLEMENTARY TABLE IV B.—REFRINGENCE OF ANISOTROPIC MINERALS—*continued*

N_o or N_m +	N_o or N_m −	N_g or N_g-N_p	N_p	Mineral	Chem.	Cleavage, Opt. Orient.	Other Characters	Page
1.749		1.749	1.724	*Allodelphite*	Sil.	?	Brown	440
1.750		1.752	1.750	*Abukumalite*	Phos.	Poor cleav.	G.=4.35	*
1.751		1.761	1.750	*Synadelphite*	Arsen.	X∧c=45°	Brown: X=Y<Z	155
	1.76	1.76	1.72	*β-Uranopilite*	Sul.	Y ∥ Elong.	2V=Sm.	**
1.763		1.783	1.759	*Austinite*	Arsen.	110; Z=*b*	Y=*a* G.=4.12	***
1.764		1.794	1.763	*Clinoferrosilite*	Sil.	110	Z∧c=35°	*4
1.765±		1.775	1.760	*Alluaudite*	Phos.	Z⊥best cl.	G.=3.58	*5
	1.765	1.839	1.735	*Murmanite*	Sil.	001⊥X±	X=pink; Y=brown; Z=**brown**	*6
1.767		1.823	1.748	*Joaquinite*	Sil.	Y=*b*; Z=*c*	G.=5.80	417
	1.769	1.769	1.760	*Ca-Larsenite*	Sil.	?	G.=4.42	187
1.770		1.840	1.710	*Rossite*	Van.	010	G.=2.45	158
	1.775	1.777	1.772	*Britholite*	Sil.	X=*c*; Y=*a*	Ps. Hex.	441
	1.78±	1.80±	?	*Vandenbrandeite*	Uran.	001, 110	G.=4.96. Abn. interf. col.	*7
	1.78±	0.035		*Taosite*	Ox.	?	X=yellow. Z=red-brown	*8
	1.780	1.792	1.756	*Alleghanyite*	Sil.	X∧a=−35°	G.=4.02	*9
	1.80	1.80	1.75	*Ammoniojarosite*	Sul.	0001⊥X	Soluble in HCl	114
	1.810	1.816	1.787	*Arsenoclasite*	Arsen.	010; X=*b*	Y=*a*. G.=4.16	133
1.864		1.894	1.851	*Plumbosynadelphite*	Arsen.	?	Brown. X<Y<Z	*10
1.89		1.90	1.88	*Dumontite*	Phos.	Y=*c*; Z=*a*	Yellow: X<Y	148
	1.90	1.92	1.674	*Ianthinite*	Ox.	100⊥X	Y=*c*	60
	1.902	1.908	1.870	*Talasskite*	Sil.	001⊥Y	X=*b*	*11
	1.905	1.910	1.873	*Yeatmanite*	Sil.	100⊥X±	G.=4.8	*12
	1.905	1.905	1.785	*Argentojarosite*	Sul.	0001⊥X	Yellow: O>E	114

1.930	1.939	1.886	*Fersmanite*	Tit.	$Y=b$. $X\perp 001\pm$	Brown. G.=3.44	168
1.95	1.96	1.92	*Larsenite*	Sil.	$X=a$; $Y=c$.	G.=5.9	187
2.002	2.02	1.93	*Lindgrenite*	Molyb.	$010\perp Z$	2V=71°. G.=4.26	*13
2.06	2.08	2.03	*Duftite*	Arsen.	Orth.?	G.=6.19	132
2.07	2.12	?	*Curite*	Uran.	$Z=c$	G.=7.19	103
2.098	2.108	1.997	*Clarkeite*	Uran.	?	2V=40°±. G.=6.39	111
2.222	2.224	2.186	*Fervanite*	Van.	Incl. Ext.	2V=Sm.	142

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TABLE V.—DISPERSION OF MINERALS

The new methods of studying powdered minerals lead naturally, not only to a knowledge of their indices of refraction in ordinary light, but also and simultaneously to a knowledge of the variation in their indices with variation in the wave-length (or color) of light; that is, the new methods lead to a knowledge of the dispersion of the minerals. Of course the dispersion of a mineral is as definite a physical property as its refringence or birefringence and may therefore be used to identify it. At present, data regarding the dispersion of minerals are remarkably scanty and in some cases not very accurate.

The dispersion given is always the difference between the index in light of 4861 Å wave-length (= the Frauenhofer line *F* or the β line of hydrogen) and the index in light of 6563 Å wave-length (= the Frauenhofer line *C* or the α line of hydrogen). In the tables this dispersion is meant by the expression *F–C*.

In anisotropic crystals the dispersion of the substance is, in general, not the same for light vibrating in directions which are crystallographically unlike. Therefore the dispersion for N_g is not the same as for N_p, and the dispersion for N_m is not equal to that for N_g nor to that for N_p. However, these differences are usually small, and the only dispersion given in the table is that for N of isotropic substances, N_o of uniaxial substances and N_m of biaxial substances.

In the literature [1] the dispersion is very rarely given directly and the indices measured for different wave-lengths do not always include the wave-lengths of the *F* and *C* lines here used as standards. Therefore it has been necessary to obtain the dispersion given in the table by calculation or graphic solution in many cases. In cases in which this involves notable extrapolation the result is given as a ± value and the extrapolation involved is indicated in footnotes.

In the following table minerals are classified first on the basis of their dispersion, and in each group thus established they are arranged

[1] For references to the literature see A. N. Winchell: Dispersion of Minerals, *Am. Mineral*, XIV, 1929, p. 125.

in the order of increasing refringence. This table is remarkably incomplete even though it includes all available data.

For methods of measuring the index of refraction with different wave-lengths of light and thus obtaining the dispersion, see Part I, pages 228–239 and 244–248.

For methods of estimating or measuring the birefringence of minerals, see Part I, pages 119–123, 136–138, and 244–246.

For methods of determining the optic sign, see Part I, pages 129–135, 138, 148–152, 169, 206–213, and 228–239.

For methods of estimating or measuring the optic axial angle, see Part I, pages 186–189, 210, 226–227, and 239–244.

For a discussion of cleavage in minerals, see Part I, pages 29–32.

For a list of abbreviations and symbols, see page xiii.

TABLE V.—DISPERSION OF MINERALS

N, N_o or N_m F−C	N, N_o or N_m D	$N_g - N_p$	Mineral	Chem.	Sign	2V	Other Characters	Page
			Section 1. $N_F - N_C = .000$ to .0075					
.0062	1.309	.004	**Ice**	H_2O	+	0°	Index extremely low	40
.0039	1.328	Very weak	*Villiaumite*	NaF	−	0°	Red. Sol. hot H_2O	30
.004±[a]	1.340	.000	*Cryolithionite*	Hal.	..	....	110 cleav.	34
.0045	1.434	.000	Fluorite	CaF_2	..	....	111 cleav. Tinted ±	31
.0049	1.443	.000	*Yttrofluorite*	Hal.	..	....	Poor cleav. Rare	35
.007	1.462	.015	*Picromerite*	Sul.	+	48°	$20\bar{1}$ cleav. Sol. H_2O	112
.006±[b]	1.503	.009	*Prosopite*	Hal.	+	63°	211 cleav. Rare	34
.006	1.509	.023	*Nocerite*	Hal.	−	0°	Hex. 0001 cleav.	38
.0065±[c]	1.535	.000	*Langbeinite*	Sul.	..	....	Sol. H_2O	110
.005±[d]	1.546	.006	*Eudidymite*	Sil.	+	30°	Lam. twin.	418
.007±[e]	1.581	.027	Scapolite	Sil.	−	0°	100 cleav. Tet.	293
.006±[f]	1.622	.025	**Tremolite**	Sil.	−	82°	110 cleav. at 56°	245
			Section 2. $N_F - N_C = .0075$ to .0085					
.0079	1.455	.028	Epsomite	Sul.	−	51°	010 cleav. H.=2	103
.0081	1.469	.025	Borax	Bor.	−	40°	100 cleav. Sol. H_2O	90
.0081	1.472	.009	*Boussingaultite*	Sul.	+	51°	$20\bar{1}$ cleav. Sol. H_2O	113
.0084	1.48	.031	*Goslarite*	Sul.	−	46°	010 cleav. Sol. H_2O	104
.008±[g]	1.489	.025	*Morenosite*	Sul.	−	42°	010 cleav. Sol. H_2O	103
.008	1.508	.000±	**LEUCITE**	Sil.	+	Sm.	Trapezohedrons	291
.008	1.509	.071	*Pirssonite*	Carb.	+	33°	No cleav. Efferv. HCl	87
.008±[h]	1.512	.019	*Flagstaffite*	H, C, O	+	77°	Sol. alcohol	301
.008	1.518	.025	Cancrinite	Sil.	−	0°	$10\bar{1}0$ cleav.	301
.0079	1.523	.009	Gypsum	Sul.	+	58°	010 cleav. H.=2	104
.008	1.523	.006	**ADULARIA**	Sil.	−	70°±	001, 010 cleav.	361

.008	1.53	.01	**ALBITE**	Sil.	+	75°±	001, 010 cleav.	369
.0084	1.537	.004	**NEPHELITE**	Sil.	−	0°	Gel. HCl	298
.0084	1.537	.01±	**Cordierite**	Sil.	−	60°±	Ps. Hex. twin	307
.0083	1.543	.008	**OLIGOCLASE**	Sil.	±	90°±	001, 010 cleav.	371
.0078	1.544	.009	**QUARTZ**	SiO_2	+	0°	No cleav. Insol.	54
.008± [i]	1.544	.002	*Epididymite*	Sil.	+	23°	001, 010 cleav. Ps. Hex.	418
.0084	1.549	.015	*Edingtonite*	Sil.	−	50°	110 cleav. Gel. HCl	389
.008	1.554	.016	*Grothine*	Sil.	+	Mod.	$X=b$; $Y=c$	432
.008± [h]	1.558	.010	*Beryllonite*	Phos.	−	68°	001, 100 cleav.	149
.0078	1.575	.044	Anhydrite	$CaSO_4$	+	42°	001, 010, 100 cleav.	98
.008	1.593	.013	**Celsian**	Sil.	+	80°±	001, 010 cleav.	359
.008± [j]	1.599	.04±	**MUSCOVITE**	Sil.	−	40°±	001 cleav.	267
.0078	1.618	.01	Topaz	Sil.	+	60°±	001 cleav. H.=8	198
.0084	1.623	.009	Celestite	$SrSO_4$	+	51°	001, 110, 010 cleav.	99
.008± [k]	1.635	.021	**ANTHOPHYLLITE**	Sil.	−	88°±	110 cleav. at 55°	240
.008± [l]	1.65±	.005±	**Melilite**	Sil.	−	0°	Tet. Gel. HCl	208
.008± [m]	1.66±	.03±	*Eosphorite*	Phos.	−	40°	100 cleav. Sol. HCl	156

Section 3. $N_F-N_C=.0085$ to $.0095$

.009 [b]	1.478	.015	*Melanterite*	Sul.	+	82°	Sol. H_2O	106
.009± [n]	1.479	.012	Natrolite	Sil.	+	62°	110 cleav. Acic.	390
.009± [o]	1.483	.000	**Sodalite**	Sil.	..	....	Poor cleav. Gel. HCl	289
.0091	1.52	.025	Cancrinite	Sil.	−	0°	$10\bar{1}0$ cleav.	301
.009± [p]	1.525	.000	*Pollucite*	Sil.	..	....	Contains Cs	293

[a] From Tl–Li=.0026.
[b] From "blue"+"red".
[c] From $N_{Li}=1.5281$, $N_{Tl}=1.5343$
[d] From Tl−red=.0032.
[e] From Tl–Li=.0047. [f] From Tl–Li=.004.
[g] From F–D=.0061.
[h] From Tl–Li=.0055.
[i] From "green"−"red"=.0049.
[j] From Tl–Li=.0064.
[k] From "blue"−"red"=.008.
[l] From Na–"red"=.0027.
[m] From Tl–Li=.0059 for N_g and .0052 for N_p.
[n] From Tl–Li=.0054.
[o] From Tl–Li=.0059.
[p] From Tl–Li=.0058.

TABLE V.—DISPERSION OF MINERALS—*Continued*

N, N_o or N_m F−C	N, N_o or N_m D	N_g-N_p	Mineral	Chem.	Sign	2V	Other Characters	Page
			Section 3. N_F-N_C=.0085 to .0095—*Continued*					
.009± [a]	1.528±	.006	**ANORTHOCLASE**	Sil.	−	50°±	001, 010 cleav.	366
.0089	1.535	.002±	Apophyllite	Sil.	±	0°	Abn. int. colors	262
.0087	1.538±	.004	**NEPHELITE**	Sil.	−	0°	Gel. HCl	298
.009± [b]	1.54	.017	*Gismondite*	Sil.	−	84°	Gel. HCl	373
.009±	1.55	.01±	**Cordierite**	Sil.	−	Lg.	Ps. Hex. twin.	307
.0086	1.553±	.007	**ANDESINE**	Sil.	±	90°±	001, 010 cleav.	372
.0087	1.558	.010	*Beryllonite*	Phos.	−	68°	001, 100 cleav.	149
.009	1.562±	.008	**LABRADORITE**	Sil.	+	80°±	001, 010 cleav.	374
.009 [c]	1.572±	.006	Beryl	Sil.	−	0°	Colorless or tinted	212
.0093	1.572±	.009	**BYTOWNITE**	Sil.	−	85°±	001, 010 cleav.	376
.0095	1.58±	.012	**ANORTHITE**	Sil.	−	77°	001, 010 cleav.	378
.009	1.586	.074	*Hambergite*	Bor.	+	87°	010, 100 cleav.	91
.009± [d]	1.587±	.03±	Scapolite	Sil.	−	0°	100 cleav. Tet.	293
.009	1.592	.028	*Colemanite*	Bor.	+	55°	010 cleav. Sol. HCl	93
.0094	1.602	.000	*Zunyite*	Sil.	..	....	111 cleav. Insol.	414
.009	1.637	.012	Barite	BaSO.	+	37°	001, 110 cleav.	100
.009	1.645±	.025±	**Tourmaline**	Sil.	−	0°	Max. absorp. ⊥c	301
.009	1.654	.016	Phenakite	Sil.	+	0°	$11\bar{2}0$ cleav.	185
.009	1.655	.015	*Euclase*	Sil.	+	50°	010 cleav.	432
.009± [e]	1.66	.02±	**Sillimanite**	Sil.	+	30°±	010 cleav. Acic.	200
			Section 4. N_F-N_C=.0095 to .0105					
.010± [f]	1.484	.000	**Sodalite**	Sil.	..	....	Poor cleav. Gel. HCl	289
.010± [g]	1.510	.012	*Petalite*	Sil.	+	84°	001 cleav.	309
.01± [h]	1.514	.000	*Northupite*	Carb.	..	....	No cleav. Efferv. HCl	85

.010± [i]	1.572±	.005±	Beryl	Sil.	−	0°.	Tinted ±	212
.0095	1.58±	.012	**ANORTHITE**	Sil.	−	80°±	001, 010 cleav.	378
.01± [j]	1.587±	.04	**MUSCOVITE**	Sil.	−	40°±	001 cleav.	267
.010	1.592	.028	Colemanite	Bor.	+	55°	010 cleav. Sol. HCl	93
.010± [k]	1.617	.022	Hemimorphite	Sil.	+	46°	110 cleav. Gel. HCl	211
.01± [l]	1.634	.006	*Danburite*	Sil.	−	87°	Poor cleav. Disp.	210
.010±	1.638±	.004	**Apatite**	Phos.	−	0°	Hex. Prism.	129
.01±	1.64±	.025±	**Tourmaline**	Sil.	−	0°	Max. absorp. ⊥c	301
.01± [m]	1.658	.02±	**Sillimanite**	Sil.	+	30°±	010 cleav. Acic.	200
.010± [n]	1.665	.015	Spodumene	Sil.	+	60°±	110 cleav. at 87°	236
.010	1.672	.099	*Parisite*	Carb.	+	0°	0001 cleav. Efferv. HCl	85
.01± [o]	1.722	.048	Diaspore	Ox.	+	84°	Y⊥010 cleav	46
.01± [o]	1.72±	.000	Spinel	$MgAl_2O_4$	..	....	Oct. H.=8	62
.01± [p]	1.729	.025	*Ganophyllite*	Sil.	−	24°	001 cleav.	436

Section 5. N_F-N_C=.0105 to .0115

.011	1.490	.000	Sylvite	KCl	..	....	Sol. H_2O	30
.011± [q]	1.522	.007	**MICROCLINE**	Sil.	−	83°	001, 010 cleav.	364
.0115	1.566	.02±	Brucite	$Mg(OH)_2$	+	0°	0001 cleav.	42
.011±	1.575±	.006±	Beryl	Sil.	−	0°	Colorless or tinted	212
.0113± [r]	1.590	.035±	Scapolite	Sil.	−	0°	Tet.	293
.011	1.645±	.025±	**Tourmaline**	Sil.	−	0°	Max. absorp. ⊥c	301
.0106	1.678	.028	**DIOPSIDE**	Sil.	+	59°	110 cleav. at 87°	224

[a] From Na-Li=.003.
[b] From Tl-Li=.0061.
[c] From Cd-green-Li=.0074.
[d] From Tl-Li=.0063.
[e] From Tl-Li=.0068
[f] From Tl-Li=.0061.
[g] From "blue"-"red"=.010.
[h] From Tl-Li=.0063.
[i] From E-B=.0068.
[j] From Tl-Li=.0071.
[k] From Tl-Li=.006.
[l] From Tl-Li=.0063.
[m] From Tl-Li=.0069.
[n] From Tl-Li=.0063.
[o] From "blue"-"red"=.010.
[p] From Na-Li=.0037.
[q] From Tl-Li=.0063.
[r] From Tl-Li=.0068.

TABLE V.—DISPERSION OF MINERALS—*Continued*

N, N_o or N_m		$N_g - N_p$	Mineral	Chem.	Sign	2V	Other Characters	Page
F−C	D							
			Section 5. $N_F - N_C = .0105$ to .0115—*Continued*					
.0114	1.722	.012	**Kyanite**	Al_2SiO_5	−	82°	100, 010 cleav.	205
.011± [a]	1.747	.009	*Chrysoberyl*	$BeAl_2O_4$	+	65°±	H.=8.5. G.=3.64	65
.0106	1 77	.008	Corundum	Al_2O_3	−	0°	H.=9. G.=4.1	43
.011± [b]	1.814	.000	**Spessartite**	Sil.	..	....	H.=7. G.=4±. Insol.	178
			Section 6. $N_F - N_C = .0115$ to .0125					
.012± [c]	1.534	.027	Wavellite	Phos.	+	72°	101, 010 cleav.	144
.012± [d]	1.539	.028	*Mellite*	Al, C, O, H	−	0°	Yellow±. Tet.	88
.0115	1.564	.02	Brucite	$Mg(OH)_2$	+	0°	0001 cleav.	42
.012± [e]	1.570±	.006	Beryl	Sil.	−	0°	Colorless or tinted	212
.012±	1.59±	.010±	**Clinochlore**	Sil.	+	0°±	001 cleav.	283
.012± [f]	1.595	.027	*Leucophane*	Sil.	−	39°	001, 100, 010 cleav.	210
.012± [g]	1.613	.019	*Meliphanite*	Sil.	−	0°	001 cleav. Tet.	210
.0123	1.639	.004	**Akermanite**	Sil.	+	0°	110 cleav. Tet.	209
.012± [g]	1.652	.025±	**Tourmaline**	Sil.	−	0°	Max. absorp. ⊥ elong.	301
.0117± [c]	1.66	.02±	**Sillimanite**	Sil.	+	30°±	010 cleav. Acic.	200
.012± [h]	1.662	.017	Monticellite	Sil.	−	75°	Poor cleav. Gel. HCl	187
.012±	1.667	.011	*Boracite*	Bor.	+	83°	Ps. Isom. twin.	94
.0123	1.681	.155	**Aragonite**	$CaCO_3$	−	18°	Ps. Hex. twin.	79
.012± [i]	1.682	.035	*Pyrosmalite*	Sil.	−	0°	0001 cleav. Gel. HCl	408
.012± [i]	1.688	.004	Triphylite	Phos.	+	0°±	001, 010 cleav. Gel. HCl	149
.012± [j]	1.694	.002	*Rhodizite*	Bor.	?	?	Ps. Isom. Insol.	94
.0124	1.713±	.039	**Olivine**	Sil.	+	84°±	Poor cleav. Gel. HCl	189
.012± [k]	1.719	.000	Spinel	$MgAl_2O_4$	..	....	Oct. H.=8	62

.0125± [l]	1.744±	.000	**Pyrope** (pure)	Sil.	..	....	G.=3.5. Insol.	178
.0125	1.745	.012	**Staurolite**	Sil.	+	85°±	010 cleav. Golden	202
.012±	1.763±	.050±	**EPIDOTE**	Sil.	−	70°±	001 cleav. Golden	314
			Section 7. N_F-N_C=.0125 to .0135					
.013± [m]	1.474	.021	*Thenardite*	Sul.	+	83°	001 cleav. Sol. H_2O	96
.0127	1.544	.000	Halite	NaCl	..	....	100 cleav. Sol. H_2O	29
.013±	1.570±	.021	**Scapolite**	Sil.	−	0°	Tet.	293
.0127 [n]	1.582	.006	Beryl	Sil.	−	0°	Colorless or tinted	212
.013± [m]	1.59±	.010	**Clinochlore**	Sil.	+	0°±	001 cleav. Mono.	283
.013± [m]	1.651	.035	**Forsterite**	Sil.	+	85°	Poor cleav. Gel. HCl	188
.0134	1.658	.172	**CALCITE**	$CaCO_3$	−	0°	$10\bar{1}1$ cleav. Efferv. HCl	71
.013 [o]	1.644	.053	Dioptase	Sil.	+	0°	$10\bar{1}1$ cleav. Gel. HCl	186
.0132	1.672	.011	*Hardystonite*	Sil.	−	0°	001 cleav. Gel. HCl	209
.0133	1.679	.177	**DOLOMITE**	Carb.	−	0°	$10\bar{1}1$ cleav. Efferv. HCl	73
.0127	1.681	.155	**Aragonite**	$CaCO_3$	−	18°	Ps. Hex. twin.	79
.0127	1.682	.000±	*Thorite*	$ThSiO_4$	+	0°	110 cleav. Tet.	185
.013± [m]	1.685±	.010	**Axinite**	Sil.	−	75°±	Wedge shape. Pleo.	425
.0132	1.701±	.04±	**OLIVINE**	Sil.	−	85°±	Poor cleav. Gel. HCl	189
.0132	1.704±	.025±	**AUGITE**	Sil.	+	61°	110 cleav. at 87°	228
.0127	1.717±	.005	**Clinozoisite**	Sil.	+	64°	001 cleav.	312
.013	1.738	.000	*Periclase*	MgO	..	....	100 cleav. Sol. HCl	41
.013	1 74±	.000	**Grossularite**	Sil.	..	....	G.=3.5. Insol.	180
.013± [p]	1.745±	.000	**Pyrope**	Sil.	..	....	G.=3.5. Insol.	178

[a] From Tl-Li=.0072.
[b] From Tl-Li=.0084.
[c] From "blue"-"red"=.012
[d] From E-B=.009.
[e] From E-B=.0084.
[f] From Na-Li=.004.
[g] From Tl-Li=.0064.
[h] From Tl-Li=.0059.
[i] From Tl-Li=.008.
[j] From Tl-Li=.007.
[k] From Tl-Li=.0074.
[l] From Tl-Li=.0086.
[m] From "blue"-"red"=.013.
[n] From E-B=.0086.
[o] From F-D=.0126.
[p] From Tl-Li=.009±.

TABLE V.—DISPERSION OF MINERALS—*Continued*

N, N_o or N_m		$N_g - N_p$	Mineral	Chem.	Sign	2V	Other Characters	Page
F−C	D							
			Section 7. $N_F - N_C = .0125$ to $.0135$—*Continued*					
.0127	1.75±	.012	**Staurolite**	Sil.	+	85°±	010 cleav. Golden	202
.013± [a]	1.793	.053	*Thortveitite*	Sil.	−	66°	110 cleav. Green	211
.013± [b]	1.804±	.000	**Spessartite**	Sil.	..	....	G.=4.2. Insol.	178
			Section 8. $N_F - N_C = .0135$ to $.0155$					
.0138 [c]	1.555	.160	*Whewellite*	Oxal.	+	84°	001, 010 cleav. Organic	89
.014± [d]	1.60±	.05±	Vivianite	Phos.	+	85°±	010 cleav. Blue-green	126
.014± [e]	1.654	.025	Tourmaline	Sil.	−	0°	Max. absorp. ⊥c	301
.0136	1.658	.172	**CALCITE**	$CaCO_3$	−	0°	$10\bar{1}1$ cleav. Efferv. HCl	71
.014± [f]	1.658	.015	**HORNBLENDE**	Sil.	−	80°±	110 cleav. at 56°	247
.014± [g]	1.668	.016	*Rinkite*	Sil.	+	43°	100 cleav. Yellow	423
.0137	1.670	.013	*Justite*	Sil.	−	0°	Tet. Gel. HCl	209
.0142	1.672	.011	*Hardystonite*	Sil.	−	0°	Tet. Gel. HCl	209
.014± [h]	1.685±	.010	**Axinite**	Sil.	−	75°±	Wedge-shaped. Pleo.	425
.014± [i]	1.692	.18±	**DOLOMITE**	Carb.	−	0°	$10\bar{1}1$ cleav. Efferv. HCl	73
.0145	1.717±	.005±	**Clinozoisite**	Sil.	+	70°±	001 cleav.	312
.015± [j]	1.721	.095	Xenotime	Phos.	+	0°	110 cleav. Tet.	138
.014± [k]	1.726	.023	**PYROXENE**	Sil.	+	60°±	110 cleav. at 87°	213
.014	1.737	.000	*Periclase*	MgO	..	....	100 cleav. Sol. HCl	41
.014± [l]	1.745	.000	**Pyrope**	Sil.	..	....	G.=3.5. Insol.	178
.014±	1.745	.000	**Grossularite**	Sil.	..	....	G.=3.5. Insol.	180
.015± [m]	1.80±	.000	**Almandite**	Sil.	..	....	G.=4.25. Insol.	178
.015 ± [n]	1.815±	.000	**Spessartite**	Sil.	..	....	G.=4.2. Insol.	178

Section 9. N_F-N_C=.0155 to .0195

.0187	1.505	.171	Niter	KNO_3	−	7°.	011 cleav. Sol. H_2O	89
.018	1.54±	.06±	*Copiapite*	Sul.	+	60°±	001 cleav. Yellow	108
.019±	1.550.	.102	*Rhomboclase*	Sul.	+	Sm.	001 cleav. Red	108
.019	1.585	.248	*Nitratite*	$NaNO_3$	−	0°	10$\bar{1}$1 cleav. Sol. H_2O	89
.016± [o]	1.589	.001	*Rinneite*	Hal.	+	0°	Abn. int. colors	33
.0167	1.642	.000	*Salammoniac*	NH_4Cl	..	....	Poor cleav. Sol. H_2O	30
.017± [p]	1.653	.045	Datolite	Sil.	−	74°	No cleav. Gel. HCl	424
.016	1.694	.029	Willemite	Sil.	+	0°	0001 cleav. Gel. HCl	186
.017± [q]	1.720	.011	*Trimerite*	Sil.	−	83°	001 cleav. Sol. HCl	401
.016± [r]	1.737	.019	**Hedenbergite**	Sil.	+	60°	110 cleav. at 87°	224
.016-.018±	1.74±	.03±	**EPIDOTE**	Sil.	−	80°±	001 cleav. Golden	314
.016± [s]	1.745	.087	*Libethenite*	Phos.	−	83°±	Poor cleav. Green	132
.016± [t]	1.746	.000	**Pyrope**	Sil.	..	....	G.=3.5. Insol.	178
.017± [u]	1.76±	.000	**Grossularite**	Sil.	..	....	G.=3.5. Insol.	180
.0165	1.79±	.05±	Monazite	Phos.	+	12°±	001 cleav. Yellow	138
.019± [v]	1.811	.000	**Spessartite**	Sil.	..	....	G.=4.2. Insol.	178
.017	1.849	.228	Smithsonite	Carb.	−	0°	10$\bar{1}$1 cleav.	78
.018± [w]	1.866	.091	*Caledonite*	Sul.	−	85°	001 cleav. Blue-green	120

Section 10. N_F-N_C=.0195 to .0245

.022± [x]	1.624	.002	*Metatorbernite*	Phos.	+	0°±	Abn. int. colors	145
.02± [y]	1.716	.026	*Woehlerite*	Sil.	−	75°±	010 cleav. Yellow	441

[a] From Tl-Li=.0094.
[b] From Tl-Li=.0097.
[c] From Tl-Li=.0086.
[d] From "violet"-"red"=.014.
[e] From Tl-Li=.0085.
[f] From F-C=.015 for N_g and .0138 for N_p as measured by V. E. Barnes at the University of Wisconsin, 1929.
[g] From Tl-Li=.010.
[h] From "blue"-"red"=.0139.
[i] From Tl-Li=.0093.
[j] From Tl-Li=.0078.
[k] From Tl-C=.0085.
[l] From Tl-Li=.0083.
[m] From Tl-Li=.010.
[n] From Tl-Li=.0105.
[o] From Tl-Li=.0094.
[p] From Tl-Li=.0085.
[q] From Tl-Li=.0081.
[r] From Tl-Li=.0092.
[s] From "blue"-"red"=.016.
[t] From Tl-red=.0071.
[u] From Tl-Li=.0097.
[v] From Tl-Li=.0108.
[w] From "blue"-"red"=.018.
[x] From Bowen's graph.
[y] From "blue"-"red"=.02

TABLE V.—DISPERSION OF MINERALS—*Continued*

N, N_o or N_m F—C	N, N_o or N_m D	N_g-N_p	Mineral	Chem.	Sign	2V	Other Characters	Page
			Section 10. N_F-N_C=.0195 to .0245—*Continued*					
.022± [a]	1.742	.000	**Garnet**	Sil.	..	....	Insol.	174
.02± [b]	1.755	.000	*Arsenolite*	As_2O_3	..	....	Oct., Mass.	43
.0204	1.786	.026	*Allactite*	Phos.	−	4°	X=green; Y, Z=yellow	155
.021± [c]	1.786	.038	Tephroite	Sil.	−	65°	Pleo. Gel. HCl	194
.02± [d]	1.807	.000	*Gahnite*	$ZnAl_2O_4$	..	....	Octahedral	63
.021 [e]	1.838	.000	*Uvarovite*	Sil.	..	....	Insol.	180
.023± [f]	1.875	.242	**Siderite**	$FeCO_3$	−	0°	$10\bar{1}1$ cleav. Efferv. HCl	76
.022± [c]	1.909	.083	**Titanite**	Sil.	+	26°	Wedge cryst. Extr. Disp.	204
.021	1.92	.016	Scheelite	$CaWO_4$	+	0°	111 cleav.	97
.023	1.93±	.05±	**Zircon**	$ZrSiO_4$	+	0°	Tet. prisms. G.=4.7	183
			Section 11. N_F-N_C=.0245 to .0295					
.029	1.652	.017	Mullite	Sil.	+	50°±	010 cleav. Pink	201
.027± [g]	1.664	.150	Strontianite	$SrCO_3$	−	11°	110 cleav. Efferv. HCl	81
.028±	1.75±	.04±	Epidote	Sil.	−	75°±	001 cleav. Golden	314
.027± [h]	1.76±	.000	**Grossularite**	Sil.	..	....	Insol.	180
.027	1.812	.000	*Beckelite*	Sil.	..	....	100 cleav. Yellow	420
.029	1.84±	.000	*Roméite*	Antim.	..	....	111 cleav. Yellow	159
.026	1.883	.017	Anglesite	$PbSO_4$	+	70°±	001, 010 cleav. G.=6.3	99
.025	2.42	.000	Diamond	C	..	....	111 cleav. H.=10	13
			Section 12. N_F-N_C=.0295 to .0495					
.03± [i]	1.75	.045	*Lorenzenite*	Sil.	+	39°	120 cleav. Rare	400
.035± [j]	1.799	.05	**Acmite**	Sil.	−	62°	110 cleav. at 87°	234

.04± [k]	1.89±	.000	**Andradite**	Sil.	..	....	Insol.	180
.033± [l]	1.90±	.09±	**Titanite**	Sil.	+	33°±	Wedge cryst. Extr. Disp.	204
.04± [m]	1.97	.011	*Powellite*	$CaMoO_4$	+	0°	111 cleav. Tet.	98
.049	1.99± •	.096	Cassiterite	SnO_2	+	0°	110 cleav. G.=7±	52
.049	2.06	.000	*Chlorargyrite*	AgCl	..	....	H.=1.5. G.=5.5	30
.046	2.06	.012	Pyromorphite	Phos.	−	0°	Hex. Sol. HNO_3	131
.035± [n]	2.074	.273	Cerussite	Carb.	−	9°	110 cleav. G.=6.5	80
.04± [o]	2.087	.000	*Senarmontite*	Sb_2O_3	..	....	Oct. Sol. HCl	43
.045± [p]	2.16 Li	.000	*Manganosite*	MnO	..	....	100 cleav. Green	41

Section 13. $N_F-N_C=.0495$ to $.0995$

.066	1.82	.09	*Carphosiderite*	Sul.	−	0°	0001 cleav. Sol. HCl	107
.057±	1.97	.683	*Calomel*	Hg_2Cl_2	+	0°	100 cleav. Tet.	30
.053 [q]	2.00	.000	*Pyrochlore*	Colum.	..	....	Oct. Brown±	163
.08	2.013	.016	Zincite	ZnO	+	0°	0001 cleav. Red±	41
.07± [r]	2.038	.287	Sulfur	S	+	69°	G.=2. Yellow±	14
.05	2.06	.000	*Chlorargyrite*	AgCl	..	....	H.=1.5. G.=5.5	30
.08	2.25	.000	*Bromyrite*	AgBr	..	....	H.=1.5. G.=6.0	30
.091	2.295	.010	*Finnemanite*	Arsen.	−	0°	$10\bar{1}1$ cleav. G.=7.2	159
.08± [s]	2.356	.022	*Wurtzite*	ZnS	+	0°	Fibrous. Pleo.	20
.09	2.368±	.000	Sphalerite	ZnS	..	....	110 cleav. Sol. HCl	19
.09± [t]	2.41±	.08±	*Stibiotantalite*	Tant.	+	75°	100 cleav. G.=7	167
.073	2.654	.043	*Moissanite*	SiC	+	0°	H.=9.5. G.=3.2	17

[a] From Tl–Li=.0145.
[b] From Na–Li=.007.
[c] From Tl–Li=.014.
[d] From "green"–"yellow"=.0126.
[e] From Tl–Li=.013.
[f] From Tl–Li=.0156.
[g] From Tl–Li=.015.
[h] From Tl–Li=.0101.
[i] From Na–Li=.009 for N_g and .011 for N_p.
[j] From Tl–"red"=.0167.
[k] From Tl–Li=.024.
[l] From Tl–Li=.022.
[m] From 1.959 for 667μμ and 1.982 for 533μμ.
[n] From E–B=.03.
[o] From Na–Li=.014.
[p] From "green"–"red"=.03.
[q] From Tl–Li=.035.
[r] From Tl–Li=.042.
[s] From Na–Li=.026.
[t] From Tl–Li=.059

TABLE V.—DISPERSION OF MINERALS—*Continued*

N, N_o or N_m		N_g-N_p	Mineral	Chem.	Sign	2V	Other Characters	Page
F—C	D							
			Section 14. N_F-N_C=.0995 to .195					
.125	2.21	.01	*Iodyrite*	AgI	+	0°	0001 cleav. G.=5.6	30
.12± [a]	2.30	.000	*Brannerite*	Ox.	..	....	Ps. Tet. G.=5±	69
.13± [b]	2.35	.000	*Marshite*	CuI	..	....	110 cleav. G.=5.6	30
.13± [c]	2.39	.14±	**Goethite**	Ox.	−	Sm.	010 cleav. Extr. Disp.	47
.134	2.41±	.098	Wulfenite	$PbMoO_4$	−	0°	111 cleav. G.=6.9	98
.12± [a]	2.481	.271	*Pyrophanite*	$MnTiO_3$	−	0°	$02\bar{2}1$ cleav. Red±	67
.142	2.56	.073	*Octahedrite*	TiO_2	−	0°	001 cleav. Pleo.	53
.13± [c]	2.59	.14±	*Brookite*	TiO_2	+	Sm.	Poor cleav. Brown	59
.158± [d]	2.60±	.286	**Rutile**	TiO_2	+	0°	Acic. G.=4.2	50
			Section 15. N_F-N_C>.195					
.21± [e]	2.23	.000	*Bunsenite*	NiO	..	....	Oct. Green	41
.23± [f]	2.47±	.000	Sphalerite	(Zn, Fe)S	..	....	110 cleav. Brown	19
.23± [g]	2.51	.023	*Greenockite*	CdS	+	0°	G.=4.8. Yellow	21
.55± [h]	2.84	Str.	*Tenorite*	CuO	−	?	Nearly opaque	41
.4± [i]	2.91	36	Cinnabar	HgS	+	0°	$10\bar{1}0$ cleav. Red	21
.33± [j]	3 087	.295	*Proustite*	Ag_3AsS_3	−	0°	$10\bar{1}1$ cleav. Scarlet	27
.34± [k]	3 176	.110	*Hutchinsonite*	Tl, As, S	−	38°	100 cleav. Scarlet	28
.5± [l]	3 22	.28	**HEMATITE**	Fe_2O_3	−	0°	Red to opaque	44

[a] From Na-Li=.04.
[b] From Tl-Li=.072.
[c] From Na-Li=.044.
[d] From Tl-Li=.105.
[e] From "blue"-"red"=.21.
[f] From Na-Li=.075.
[g] From "green"-"red"=.136.
[h] From "blue"-"red"=.55.
[i] From 599$\mu\mu$−762$\mu\mu$=.149.
[j] From Na-Li=.109.
[k] From D-C=.113.
[l] From D-C=.178.

EXPLANATION OF PLATES

PLATE I.—The colored diagram shows the relation between interference colors of crystals, the thickness of the sections and the birefringence of the crystals. The interference colors begin with darkness at the left for zero birefringence and continue through gray, white, yellow and red to the end of the first order. The second order begins with blue and continues through green and yellow to end with the second red. The third order is similar to the second order, but the colors are somewhat paler. In the fourth order the colors are still paler, and the diagram does not go beyond the fourth order because the colors in higher orders are too pale to be of much use. The vertical coordinate on the diagram gives the thickness of the section, from zero to 0.06 millimeter. The birefringence ($N_g - N_p$) is given by the figures along the top and right side of the colored portion, and these should be used with the diagonal lines across the diagram. The interference color produced by a section of any crystal depends upon the birefringence ($N_g - N_p$) of the crystal, the thickness of the section, and the direction in which the section is cut with respect to the optic axis or optic axes of the crystal. In using the diagram to determine a mineral in a thin section it is desirable to use the following procedure:

1. Determine the thickness of the section (unless it can be safely assumed to be of standard thickness, namely 0.03 mm.) by finding the highest interference color given by some known mineral such as quartz or feldspar; if quartz, with $N_g - N_p = 0.009$, gives pure white as its highest interference color, it is easy to find from the diagram that the intersection of pure white with the diagonal line for $N_g - N_p = 0.009$ is at a point indicating a thickness (on the horizontal line) of about 0.03 mm.

2. Find the highest interference color given by the unknown mineral, taking care to note the order of the colors observed (see Part I, pages 112 and 116 to 119).

3. Find the point where this highest interference color intersects the line for the measured thickness; from this point follow the diag-

onal line to the top or right side, where the birefringence of the mineral will be found, as well as the names of important minerals having that birefringence.

In using the diagram it should be remembered that only rock-forming minerals and a few others are given along the border; when studying ores, etc., the diagram will give the birefringence. but will not always give the name of the mineral.

Furthermore, the diagram is based on the assumption that all minerals have the same birefringence for light of all wave-lengths; this is only approximately true for most minerals. Therefore, slight differences of tint are to be expected between the colors of the diagram and the colors observed. It is only in very rare cases that these differences are sufficient to interfere with the use of the diagram.

Many minerals vary in composition and therefore vary in birefringence; in general, minerals are entered on the diagram as many times as necessary to express all variations in their birefringence.

Plate II.—In Plate II the most important minerals are arranged on the basis of their refringence, birefringence and optic sign. The horizontal coordinate is the refringence (N, N_o or N_m) with a change of scale at 1.85 and a range from 1.45 to 2.45. The vertical coordinate is birefringence ($N_g - N_p$) with zero birefringence in the middle of the diagram, birefringence of positive minerals from zero to 0.060 in the upper half and birefringence of negative minerals from zero to 0.060 in the lower half of the diagram.

Nearly all minerals vary in composition and therefore vary in refringence and birefringence, and, in some cases, in optic sign. All known variations in refringence and birefringence (and sign) are shown on the diagram, and this results in the condition that most minerals are represented not by points, nor even lines, but by areas. When data are sufficiently abundant and accurate the lines of the diagram are drawn as curves, as illustrated in the case of plagioclase (birefringence $= \pm 0.01 \pm$ and refringence $= 1.53$ to 1.58) and of scapolite (birefringence $= -0.02 \pm$ and refringence $= 1.56 \pm$) but in most cases data are scanty and not highly accurate—then the lines are straight. In some cases—notably in the case of ordinary hornblende (birefringence $= -0.02 \pm$ and refringence $= 1.65 \pm$)—available accurate data do not represent the limits of variation, and the area shown will be enlarged when accurate data are at hand.

When minerals vary in optic sign by passing through zero birefringence, the condition is easily shown by means of a line crossing

zero birefringence as illustrated by scapolite (birefringence $= -0.02\pm$ and refringence $= 1.56\pm$) or by means of an area crossing zero birefringence, as illustrated by chlorite (birefringence $= +0.015$ to -0.01 and refringence $= 1.55$ to 1.67). When minerals vary in sign by means of having the optic angle (2V) pass through 90°, the condition is not so easily shown on the diagram, but it is indicated by the change of full lines to dash lines in the case of plagioclase (shown both in the positive and the negative fields at birefringence $= 0.01\pm$ and refringence $= 1.53$ to 1.58) or by a full line continued by an arrow with the appropriate sign; then the continuation of the line can be found in the field of opposite sign; this condition is illustrated by the case of olivine at birefringence $= 0.036$ and refringence $= 1.65$ to 1.68 in the positive field and at refringence $= 1.68+$ and birefringence $= 0.037$ in the negative field.

The diagram permits one to find very readily all the indices of refraction of any mineral. If the mineral is isotropic, its position along the middle line (zero birefringence) gives its only index, N. The name of every anisotropic mineral on the diagram is followed by a number which gives the value of the true optic angle (2V) in degrees. If a mineral is uniaxial the name is followed by 0°; its position on the diagram gives the value of N_o and the optic sign; if the mineral is positive N_o is also N_p and N_g may be obtained by adding the birefringence to the value of N_p. If the mineral is negative N_o is also N_g and N_p may be obtained by subtracting the birefringence from the value of N_g. Finally, if the mineral is biaxial, its position on the diagram is determined by N_m and $N_g - N_p$ and the other indices (N_g and N_p) may be obtained readily from its optic sign, birefringence and optic angle by the use of the small diagram in the lower right hand corner of the main diagram. This small diagram has the true optic angle (2V) as the vertical coordinate, and, as the horizontal coordinate, it has $K = \frac{B_a}{N_g - N_p}$ and $K' = \frac{B_o}{N_g - N_p}$, in which B_a = the birefringence of the acute bisectrix section and B_o = the birefringence of the obtuse bisectrix section. For positive minerals, $K = \frac{N_m - N_p}{N_g - N_p}$ and $K' = \frac{N_g - N_m}{N_g - N_p}$ and, for positive minerals K' is the (decimal) fraction of the birefringence ($N_g - N_p$) which must be added to N_m in order to obtain N_g and K is the (decimal) fraction of the birefringence which must be subtracted from N_m to obtain N_p; for negative minerals K' is the

(decimal) fraction of the birefringence which must be subtracted from N_m in order to obtain N_p and K is the (decimal) fraction of the birefringence which must be added to N_m in order to obtain N_g. Accordingly, K′ gives the decimal fraction of the birefringence to be added to or subtracted from N_m, *as suggested by the optic sign*, to obtain another index, and K gives the decimal fraction of the birefringence to be added to or subtracted from N_m, *contrary to the suggestion of the optic sign* to obtain the third index. For example, from the main diagram anhydrite is positive with $2V=42°$, $N_m=1.576$ and $N_g-N_p=0.044$; from the small diagram for $2V=42°$, $K'=0.87$ and $K=0.13$; accordingly, $N_g=1.576+.044\times0.87=1.614$ and $N_p=1.576-.044\times0.13=1.570$. These are the correct values of N_g and N_p.

In using this diagram to determine minerals it is desirable, first, to determine the optic sign, second, to measure the birefringence, and, third, to estimate the refringence. For the estimation of the refringence any section may be used if the birefringence of the mineral is weak, but a section showing the lowest interference color should be used if the birefringence of the mineral is not weak. Then, by making a small allowance for error in the measurement of the birefringence and a larger allowance for error in estimating the refringence, an area may be outlined on the diagram in which the unknown mineral will be found, if it is a rock-forming mineral. One reason why it is worth while to be able to obtain the other indices of refraction from the diagram is that they give the possible range of refringence which the mineral may show.

Plate III.—The stereographic plot of Wulff is a device for plotting and measuring angles in a stereographic projection. It is printed on translucent paper so as to permit the reproduction from it of as many white prints as may be desired for use in the study of the optic properties of feldspars and in the study of any biaxial minerals by the methods of the universal stage.

INDEX

I

J

T

U

V

For explanation of plates, see page 213.